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PENSOFT

Fish fauna from the estuaries of Ceará state, Brazil: a checklist in support of conservation of the Brazilian semiarid coast

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Abstract. We extensively surveyed eight estuaries along the coast of the state of Ceará in northeastern Brazil. We include local samples and data compiled from online databases and the literature. Our sampling resulted in a checklist of the estuarine fish fauna, 126 species, and provides original information from some of the estuaries. Most of the sampled marine species are widely distributed, and many are important commercial species for artisanal fisheries. The addition of records from existing inventories and online collections increases the number of species to 245, of which 11 are threatened (Critically Endangered or Vulnerable) and six are introduced. Our study provides an updated list of fish species of the estuaries along the semiarid coast of Brazil and is intended to support further research, conservation, and management efforts.

Keywords. Caatinga, estuarine fishes, ichthyofauna, inventory, mangrove, northeastern Brazil

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Introduction

The richness, composition, and geographical distribution of species in an area are essential information to guide taxonomic, systematic, ecological, biogeographic, and conservation studies (Gotelli and Colwell 2001; Henriques et al. 2016), especially when addressing dynamic environments where faunal assemblages and habitats are influenced in time and space by tides and annual seasonality (Day et al. 2013; Silva et al. 2016, 2021). In estuaries, the effects of environmental fluctuations on the occurrence and distribution of fish species can hardly be overstated (Elliott et al. 2007; Neves et al. 2011; Potter et al. 2015). A good example is the semiarid coastal regions of northeastern Brazil, which comprises part of Maranhão to northern Rio Grande do Norte states (Soares et al. 2021). Here, most of the river systems are small and intermittent, with hypersaline mangroves and meadows (Valentim et al. 2018; Soares et al. 2021).

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These estuaries are often neglected, despite their social-economic importance for artisanal fisheries (Basílio and Garcez 2014) and their role in providing microhabitats and nursery grounds for a varied assortment of coastal and reef fishes (Sales et al. 2016). In recent decades, a reduction in precipitation has been observed (Marengo et al. 2018), and the Brazilian semiarid coast is now considered one of the regions most vulnerable to climate change in South America due to rising sea levels and increasing frequency of droughts (Utida et al. 2019). Therefore, drastic changes in estuarine salinity, decreased land-to-ocean matter flux, and acidification are possible, and, therefore, fish assemblages may change over time (Soares et al. 2021). This can potentially limit or extend the occurrence of fish species, depending on whether they are of continental or of marine origin (Potter et al. 2015; Lauchlan and Nagelkerken 2020).

Tropical estuaries are rich in biodiversity, especially fishes (Blaber 2000), and there has been an increasing number of inventories published on the fish fauna in northeastern Brazil over the past few decades (Andrade-Tubino et al. 2008; Paiva et al. 2014; Lira et al. 2015; Costa et al. 2017; Guimarães-Costa et al. 2019; Medeiros et al. 2019; Lima et al. 2020). Published taxonomic surveys on the fish fauna in estuaries of Ceará state are few in both space and time, and they are often part of grey literature. One of the first surveys, conducted in the 1960s, included four estuaries and reported 31 fish taxa (Menezes and Menezes 1968). An inventory focusing entirely on fishes had to wait for another decade; Oliveira (1976) recorded 86 species in the Jaguaribe estuary, part of the largest river basin in Ceará. Another 20 years passed before the next survey was published, which included 85 species (Alves and Soares-Filho 1996). Araújo et al. (2000) produced a list of over 102 species by compiling unpublished studies on the ichthyofauna of the estuaries of the Cocó, Jaguaribe, and Pacoti rivers. Later, as part of the Ecological and Economic Zoning Program (EEZ), 17 estuaries were surveyed and subsistence fishermen were interviewed using photographs of fish species (EEZ 2005). Some new occurrences were reported by Basílio et al. (2009) in a study on the fish fauna of the Curu river estuary, and Soares-Filho et al. (2010) sampled and compiled the fish fauna of seven estuaries of the state. The most recent contributions are fish inventories from the Mundaú river basin (Teixeira et al. 2017) and the Timonha-Ubatuba estuary (Melo et al. 2021).

Most previous surveys include outdated systematic nomenclature or unvouchered specimens. This makes reliable identification and confirmation difficult, which is needed for the management of fishing and conservation. The estuaries of Ceará have seen environmental impacts such as overexploitation, the introduction of exotic species, shrimp farming, and climatic changes in the last decades (Gorayeb et al. 2005; Santana et al. 2015; Ferreira and Lacerda 2016; Soares et al. 2021). Therefore, we provide an ichthyological survey of eight estuaries from the northern reaches of semiarid northeastern Brazil. Included here is an extensive species list, which should support the monitoring of ichthyofaunal changes, as well as ecological studies and efforts to manage and conserve the fish fauna.

Study Area

The sampled estuaries—Aracatiaçu, Aracatimirim, Choró, Cocó, Curu, Malcozinhado, Pacoti, and Pirangi rivers—are located in the Northeastern Brazil marine ecoregion (Spalding et al. 2007) and in the continental ecoregion referred to as Mid-Northeastern Caatinga (Abell et al. 2008; Lima et al. 2017). According to the Köppen climate classification system (Alvares et al. 2014), the coastal region of Ceará has an "As" climate type (Tropical savanna climate with dry-summer characteristics). The mean annual rainfall is 1,000–1,300 mm, but the climate is strongly influenced by the dynamics of the semiarid Caatinga (BSh climate: Hot semi-arid), with its markedly seasonal precipitation of less than 800 mm, which is concentrated in the first six months. Thus, many estuaries in the northernmost part of northeastern Brazil—the semiarid coast of Brazil (Soares et al. 2021)—display seasonal hypersalinity, with an inverted gradient in the second half of the year (Valentim et al. 2018; Soares et al. 2021). The fluvial discharge into these estuaries is strongly affected by water-resource management (e.g., reservoirs within the river basins), and during the dry season the flow may be reduced to less than 1 m^3/s (Molisani et al. 2006; Valentim et al. 2018).

These estuaries are heavily impacted by human activities, including mangrove deforestation, fishing, fires, landfills and waste disposal, dam construction, shrimp farming, agricultural and urban runoff, domestic sewage, and unregulated tourism. In addition to the direct impacts, many of these activities involve the discharge of heavy metals, pesticides, pathogens, nutrients, surfactants, and pharmacological residues into the environment (Gorayeb et al. 2005; Meireles et al. 2007; Lacerda et al. 2014; Santana et al. 2015; Ferreira and Lacerda 2016; Pimentel et al. 2016). Management plans are currently being drafted for the Environmental Protected Area (EPA) of the Pacoti estuary and the EPA of the Curu estuary, while the plan implemented for a third conservation unit (Cocó State Park) incorporates the present fish survey (SEMA 2020).

Methods

Fish were collected from estuaries along the semiarid coast of Ceará state between 2014 and 2021. We conducted six to eight bimonthly campaigns in each estuary, covering the entire estuarine area (Fig. 1). Collections were made under license from ICMBio/SISBio (#43014, #57780, #64269). Sampling was carried out during ebb and flood tides during the day using a seine net (25 m long ×2 m high and with a mesh size of 12 mm) at depths between 0.3 and 1.5 m, or using casting

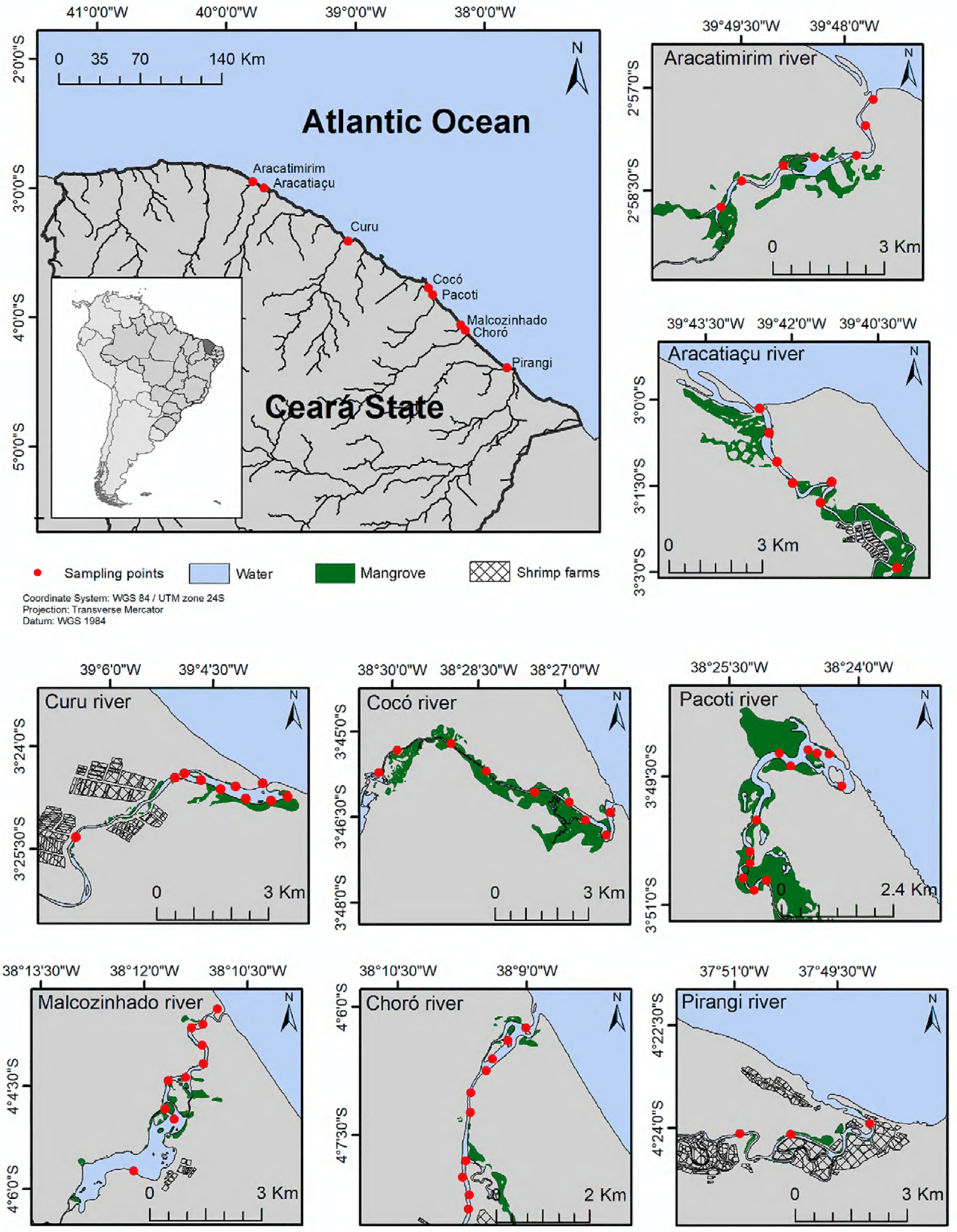

Figure 1. Sampling sites in eight estuaries of the state of Ceará, Brazil: Aracatimirim, Aracatiaçu, Curu, Cocó, Pacoti, Malcozinhado, Choró, and Pirangi river estuaries.

nets (3 m high, with a mesh size of 25 mm) in the main channels at depths between 0.5 and 3.5 m. Additionally, we used sieve nets (0.2 m^2 with a mesh size of 1 mm) and gillnets of varying mesh size (30–70 mm between opposite knots) to collect fish in areas with mangrove roots and in pools and inlets off the main channel. Our collected specimens were complemented by catches of local fishermen. The collected specimens were anesthetized in ice and subsequently fixated in 10% formalin for 48 hours, followed by preservation in 70% alcohol. Following the protocols of Malabarba and Reis (1987), batches of specimens were deposited in the fish collections of the Federal University of Rio Grande do Norte (UFRN), the Federal University of Paraíba (UFPB), and

the National Museum of the Federal University of Rio de Janeiro (MNRJ). To build a more comprehensive list, we compiled records from the speciesLink online database (CRIA 2022) and the literature (Menezes and Menezes 1968; Oliveira 1976; Alves and Soares-Filho 1996; Araújo et al. 2000; EEZ 2005; Freitas et al. 2006; Basílio et al. 2009; Soares-Filho et al. 2010; Costa and Lacerda 2014; Teixeira et al. 2017; Melo et al. 2021).

We identified our specimens to the lowest taxonomic category based on original descriptions, taxonomic reviews or dichotomous keys following Araújo et al. (2004), Britski et al. (1984), Carpenter (2002a, 2002b), Carvalho et al. (2020), Carvalho-Filho et al. (2019); Deckert and Greenfield (1987), Figueiredo and Menezes (1978, 1980, 2000), Fischer et al. (2011), Frable et al. (2013), Garcia Jr. et al. (2010), Géry (1977), Hui and Ng (2005), Loeb and Figueiredo (2014), Lourie et al. (2016), Marceniuk (2005), Marceniuk et al. (2012, 2019a, 2019b), Menezes and Figueiredo (1980, 1985), Menezes et al. (2015), Moura and Lindeman (2007), Pezold and Cage (2001), Tencatt et al. (2017), Vicente et al. (2020) and Sabaj et al. (2022), and we adopted the systematic classification and nomenclature of valid names following Fricke et al. (2022).

The distribution of the species was categorized according to Floeter et al. (2008), Luiz Junior et al. (2008), Fricke et al. (2022), and Froese and Pauly (2022): Cosmopolitan; Circumtropical; Trans-Atlantic (both sides of the Atlantic); Western Atlantic (both hemispheres); Southwestern Atlantic (from Northern Brazil to Argentina); Greater Caribbean province (Florida to Venezuela); Brazilian province (delta of the Orinoco river, Venezuela, to Santa Catarina, Brazil); and Eastern Pacific. Freshwater species were categorized as "continental freshwater". Ordinance 445 of the Red List (Brasil 2022) ascertained which species are classified as threatened with extinction in Brazil.

Results

We collected 126 species belonging to 92 genera, 56 families, and 24 orders (Table 1). This included 224 new occurrences from individual estuaries. The most represented order was Acanthuriformes (seven families: 24 species, 19.0%), followed by Carangiformes (eight families: 23 species, 18.2%) and Clupeiformes (two families: 12 species, 9.5%). The most representative families were Gerreidae (eight species), Carangidae, Engraulidae, and Gobiidae (seven species each), and Clupeidae, Paralichthyidae, and Sciaenidae (five species each). Most species were marine and widely distributed (73 species associated with reefs, 57.9%). The result of the survey shows a mix of widely distributed species, in some cases occurring beyond the Western Atlantic (~48%), species occurring only in the provinces of the Greater Caribbean and/or Brazil (~30%), and a small number of continental freshwater species (n=15; ~12%).

If all the literature records from local estuaries are considered, the list increases by 119 species (Table 2), reaching a total richness of 245 species, 74 families, and 28 orders. The proportion of species associated with reefs and the levels of distribution are similar to the shorter list of sampled species and the longer list of all reported species.

Four of the sampled species (Table 1) are classified in the Brazilian Red List (Brasil 2022) as Vulnerable (*Hippocampus reidi*, *Megalops atlanticus*, *Mycteroperca bonaci*, and *Sciades parkeri*). Seven species are classified as Near-Threatened (*Aluterus monoceros*, *Cynoscion acoupa*, *Dormitator maculatus*, *Hyporhamphus unifasciatus*, *Lutjanus analis*, *L. jocu*, and *Mugil liza*) (SiBBr 2022). Others are classified as Data-Deficient: *Antennarius striatus*, *Archosargus probatocephalus*, *Menticirrhus martinicensis*, *Mugil curema*, *M. curvidens*, *M. rubrioculus*, *Sardinella aurita*, *Sciades proops*, and *Sphoeroides testudineus* (SiBBr 2022).

Considering the literature list, seven more species (Table 2) are classified as threatened on the Red List (Brasil 2022): Critically Endangered (*Epinephelus itajara*, *Sphyrna tiburo*), and Vulnerable (*Hippocampus erectus*, *Hypanus marianae*, *Lutjanus cyanopterus*, *Pseudobatos percellens*, *Sparisoma axillare*). Eight species are classified as Near-Threatened (*Balistes vetula*, *Carcharhinus leucas*, *C. limbatus*, *Gymnura micrura*, *Lutjanus synagris*, *Lutjanus vivanus*, *Ocyurus chrysurus*, and *Rhomboplites aurorubens*) (SiBBr 2022). Other species are classified as Data-Deficient: *Aetobatus narinari*, *Anisotremus surinamensis*, *Haemulon plumierii*, *Hemiramphus balao*, *Hypanus say*, *Menticirrhus cuiaranensis*, *Ophioscion punctatissimus*, *Pomacanthus arcuatus*, and *Rhizoprionodon porosus* (SiBBr 2022).

At least five introduced species were recorded: *Astronotus ocellatus*, *Betta splendens*, *Oreochromis niloticus*, *Poecilia reticulata*, and *P. sphenops*. All five were found in the Cocó estuary, while the other estuaries surveyed harbored up to two introduced species. One of the literature species is non-native: *Cichla ocellaris*.

Order Elopiformes
Family Megalopidae

***Megalops atlanticus* Valenciennes, 1847**
Figure 2A

Material examined. BRAZIL – Ceará • Fortaleza City, Cocó estuary; 03°45′44″S, 038°30′15″W; 28.VI.2017; Felipe B. Pereira, Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 4 specimens, sex. indet., 94.0–106.0 mm SL; UFRN4850.

Identification. Body moderately elongate and highly compressed. Head moderately short and deep, its dorsal outline nearly straight and horizontal, the back somewhat elevated, the ventral outline strongly curved anteriorly. Eye large, 3.3–4.7 times in HL. Mouth large and oblique, lower jaw prominently projecting; a gular plate present between arms of lower jaw (Carpenter 2002a).

Order Clupeiformes
Family Engraulidae

Table 1. Fish species sampled in eight estuaries in the state of Ceará, Brazil, listed in geographical order, from west to east: Aracatimirim (AM), Aracatiaçu (AR), Curu (CU), Cocó (CO), Pacoti (PA), Malcozinhado (MC), Choró (CH) and Pirangi (PI). X: species sampled in the field. X^{NO}: species sampled in the field and reported for the first time in a given estuary. X^{L}: occurrence reported in the literature (Menezes and Menezes 1968; Araújo et al. 2000; ZEE 2005; Basílio et al. 2009; Soares-Filho et al. 2010; Osório et al. 2011). (NR): new record. (I): introduced species. (*): Species associated with reefs (Floeter et al. 2008; Chaves et al. 2013; Freitas and Lotufo 2015; Pinheiro et al. 2018; Freitas et al. 2019; Araújo et al. 2020; Froese and Pauly 2022). Red List (Brasil 2022): NT: Near Threatened, VU: Vulnerable, DD: Data Deficient. Geographical distribution: C: cosmopolitan, CT: circumtropical, TA: trans-Atlantic, WA: Western Atlantic, SWA: Southwestern Atlantic, Ca: Greater Caribbean Province, Br: Brazilian Province, EP: Eastern Pacific, CF: continental freshwater. The order of the species follows Fricke et al. (2022).

Taxon	Distribution	AM	AR	CU	CO	PA	MC	CH	PI	Vouchers
MYLIOBATIFORMES										
Dasyatidae										
Hypanus guttatus (Bloch & Schneider, 1801) (*)	Ca+Br	X	X^{L}	X^{L}	X^{L}	X	X	X	X^{L}	UFPB12050; UFRN4559; 4711
ELOPIFORMES										
Elopidae										
Elops saurus Linnaeus, 1766 (*)	WA	X	X	X^{L}	X	X	X	X	X^{L}	UFRN4545; 4817; 4697; 4498
Megalopidae										
Megalops atlanticus Valenciennes, 1847 (VU) (*)	TA			X^{L}	X	X^{L}	X^{NO}	X^{L}	X^{L}	UFRN4850
ALBULIFORMES										
Albulidae										
Albula cf. vulpes (Linnaeus, 1758) (*)	WA	X^{L}	X^{L}	X	X^{L}	X^{L}	X	X^{L}	X^{L}	UFRN4671
ANGUILLIFORMES										
Ophichthidae										
Myrichthys ocellatus (Lesueur, 1825) (*)	Ca+Br			X		X^{NO}		X^{NO}		UFRN4547; 4637; 4788
CLUPEIFORMES										
Engraulidae										
Anchoa hepsetus (Linnaeus, 1758)	WA	X	X	X^{L}	X^{L}	X^{L}	X	X	X^{L}	UFRN4603
Anchoa januaria (Steindachner, 1879)	SWA			X^{NO}				X^{NO}		UFRN4608; 4649
Anchovia clupeoides (Swainson, 1839)	Ca+Br	X	X	X	X^{L}	X	X	X	X	UFPB12055; 12056; 12057; UFRN4598; 4625; 4762; 4525
Anchoviella brevirostris (Günther, 1868)	Br						X^{NO}	X^{NO}		UFPB14023
Anchoviella lepidentostole (Fowler, 1911) (*)	Br								X^{NO}	URFN4517
Cetengraulis edentulus (Cuvier, 1829)	Ca+Br	X	X^{L}	X	X^{L}	X^{L}	X	X	X	UFPB12066; UFRN4607; 4657; 4535
Lycengraulis grossidens (Spix & Agassiz, 1829) (*)	Br+SWA	X	X	X	X	X	X	X	X	UFRN4609; 4849; 4628; 4770
Clupeidae										
Harengula clupeola (Cuvier, 1829)	WA						X^{NO}			UFPB12065
Lile piquitinga (Schreiner & Miranda Ribeiro, 1903) (*)	SWA	X^{NO}	X^{NO}	X^{NO}	X^{NO}	X^{NO}	X^{NO}	X^{NO}	X^{NO}	UFRN4601; 4843; 4641; 4768; 4531
Opisthonema oglinum (Lesueur, 1818) (*)	WA	X^{L}	X^{L}	X^{L}	X	X	X	X	X^{L}	UFRN4595; 4855; 4699
Rhinosardinia amazonica (Steindachner, 1879)	Br	X^{NO}	X^{NO}	X^{NO}	X^{L}	X	X^{NO}	X^{NO}	X^{NO}	UFRN4600; 4666; 4533
Sardinella aurita Valenciennes, 1847 (DD)	WA								X^{NO}	URFN4527
CHARACIFORMES										
Erythrinidae										
Hoplerythrinus unitaeniatus (Spix & Agassiz, 1829)	CF						X^{NO}			UFPB12058
Serrasalmidae										
Serrasalmus rhombeus (Linnaeus, 1766)	CF				X^{NO}			X^{NO}		UFRN4590; 4860
Curimatidae										
Steindachnerina notonota (Miranda Ribeiro, 1937)	CF		X^{NO}							UFPB12073
Prochilodontidae										
Prochilodus brevis Steindachner, 1875	CF						X^{NO}			UFPB12064
Characidae										
Astyanax bimaculatus (Linnaeus, 1758)	CF	X^{NO}	X^{NO}	X^{NO}	X^{NO}	X^{NO}	X^{NO}			UFRN4821; 4616; 4763
Moenkhausia costae (Steindachner, 1907)	CF				X^{NO}	X^{NO}		X^{NO}		UFRN4567; 4851; 4694
SILURIFORMES										
Callichthyidae										
Megalechis thoracata (Valenciennes, 1840)	CF				X^{NO}					UFRN4814
Auchenipteridae										
Pseudauchenipterus nodosus (Bloch, 1794)	CF	X^{NO}								UFPB12075
Ariidae										
Cathorops spixii (Agassiz, 1829) (*)	Ca+Br	X^{NO}	X^{NO}	X	X^{L}	X	X^{NO}	X	X^{NO}	UFPB12047; UFRN4586; 4605; 4665; 4692; 4506
Sciades herzbergii (Bloch, 1794)	Ca+Br	X^{NO}	X^{NO}	X	X^{L}	X	X^{NO}	X^{NO}	X^{NO}	UFPB12051; UFRN5799; 4652; 5804; 4772; 4510
Sciades parkeri (Traill, 1832) (VU)	Br			X^{NO}		X^{L}	X^{NO}	X^{NO}		UFRN4597; 4669
Sciades proops (Valenciennes, 1840) (DD)	Ca+Br	X^{NO}	X^{NO}		X^{NO}		X^{NO}			UFRN5174; 4487

Taxon	Distribution	AM	AR	CU	CO	PA	MC	CH	PI	Vouchers
AULOPIFORMES										
Synodontidae										
Synodus bondi Fowler, 1939 (*)	Ca+Br	X[NO]								UFPB12076
Synodus foetens (Linnaeus, 1766) (*)	WA	X[NO]	X	X[L]	X[L]	X			X[L]	UFRN4775
Synodus intermedius (Spix & Agassiz, 1829) (*)	WA							X[NO]		UFRN4576
BATRACHOIDIFORMES										
Batrachoididae										
Batrachoides surinamensis (Bloch & Scheneider, 1801)	Ca+Br	X	X	X	X[L]	X[L]	X	X	X	UFPB12063; UFRN4578; 4635; 4509
Thalassophryne nattereri Steindachner, 1876 (*)	Ca+Br	X[L]	X	X[L]	X[L]	X	X[L]	X[L]	X[L]	UFRN4746
SCOMBRIFORMES										
Scombridae										
Scomberomorus brasiliensis Collette, Russo & Zavala-Camin, 1978 (*)	Ca+Br			X[L]	X[L]	X[L]	X[L]	X		UFRN4604
SYNGNATHIFORMES										
Dactylopteridae										
Dactylopterus volitans (Linnaeus, 1758) (*)	TA					X[NO]				UFRN4675
Syngnathidae										
Bryx dunckeri (Metzelaar, 1919) (*)	Ca+Br			X[NO]						MNRJ53260
Hippocampus reidi Ginsburg, 1933 (VU) (*)	WA	X[L]	X[NO]	X	X	X	X[NO]	X	X[L]	UFRN4580; 4621; 4740
Microphis lineatus (Kaup, 1856)	WA					X[NO]				UFRN5179
Syngnathus pelagicus (Linnaeus, 1758)	WA	X[NO]	X[NO]	X[NO]	X[L]	X[L]		X[NO]		UFRN4588; MNRJ53261
GOBIIFORMES										
Eleotridae										
Dormitator maculatus (Bloch, 1792) (NT)	WA	X[L]	X[L]	X[L]	X	X[L]	X[L]	X[L]	X[L]	UFRN4827; 4828
Eleotris pisonis (Gmelin, 1789)	Ca+Br				X[NO]					UFRN4823; 4824
Gobiidae										
Bathygobius soporator (Valenciennes, 1837) (*)	TA	X[NO]	X[NO]	X	X	X	X	X[NO]	X	UFRN4565; 4815; 4627; 4764; 4540
Ctenogobius boleosoma (Jordan & Gilbert, 1882) (*)	WA	X[NO]	X[NO]	X	X	X	X[NO]	X[NO]		UFRN4613; 4825; 4826;4659; 4766
Ctenogobius smaragdus (Valenciennes, 1837)	WA	X[NO]	X[NO]		X[L]	X[L]	X[NO]	X[L]	X[NO]	URFN4539
Ctenogobius stigmaticus (Poey, 1860)	Ca+Br			X[NO]		X[NO]	X[NO]			UFRN4658; 4767
Evorthodus lyricus (Girard, 1858)	Ca+Br		X[NO]		X	X				UFRN4816; 4744
Gobionellus oceanicus (Pallas, 1770)	WA	X[NO]	X[NO]	X[NO]	X[L]	X	X[NO]	X	X[NO]	UFRN4572; 4633; 4682; 4528
Gobionellus stomatus Starks, 1913	Br	X[NO]		X	X[L]	X	X[NO]	X		UFRN4558; 4642; 4695; 4541
SYNBRANCHIFORMES										
Synbranchidae										
Synbranchus cf. *marmoratus* Bloch, 1795	CF				X[NO]					UFRN5170
ANABANTIFORMES										
Osphronemidae										
Betta splendens Regan, 1910 (I)	CF				X[NO]					UFRN5166; 5167
CARANGIFORMES										
Centropomidae										
Centropomus parallelus Poey, 1860	WA	X	X	X	X[NO]	X[NO]	X[NO]	X	X[NO]	UFRN4574; 4822; 4656; 4684
Centropomus undecimalis (Bloch, 1792) (*)	WA	X	X	X[L]	X[L]	X	X	X[L]	X[L]	UFRN4681; 4507
Sphyraenidae										
Sphyraena barracuda (Edwards, 1771) (*)	CT			X[NO]	X	X	X[NO]	X[L]		UFRN4863; 4634; 4736
Sphyraena guachancho Cuvier, 1829 (*)	TA				X[NO]		X[NO]			UFRN4864
Polynemidae										
Polydactylus virginicus (Linnaeus, 1758)	WA				X[L]	X				UFRN4456
Bothidae										
Bothus ocellatus (Agassiz, 1831) (*)	WA							X[NO]		UFRN4561
Paralichthyidae										
Citharichthys arenaceus Evermann & Marsh, 1900 (*)	WA	X[NO]	X[NO]			X[NO]		X[NO]	X[NO]	UFRN4714
Citharichthys spilopterus Günther, 1862 (*)	WA	X	X[NO]	X	X	X	X[NO]	X	X	UFRN4562; 4818; 4819; 4617; 4748; 4486
Citharichthys sp.	(?)							X[NO]	X[NO]	UFRN4585; 4522
Etropus crossotus Jordan & Gilbert, 1882 (*)	WA+EP	X	X[L]	X[L]	X[L]	X		X[L]	X[L]	UFRN4689
Paralichthys brasiliensis (Ranzani, 1842) (*)	SWA	X[NO]	X[NO]	X[NO]				X[NO]	X[NO]	UFRN4560; 4653
Achiridae										
Achirus achirus (Linnaeus, 1758)	WA	X[NO]	X[NO]	X	X[L]	X	X[NO]	X[NO]	X[NO]	UFPB12061; UFRN4587; 4654; 4761; 4421, 4515
Achirus declivis Chabanaud, 1940	WA		X[L]	X[L]	X[L]	X[L]			X	URFN4542
Achirus lineatus (Linnaeus, 1758) (*)	WA	X	X[NO]	X	X[L]	X	X[NO]	X	X[NO]	UFPB12062; UFRN4582; 4646; 4713
Trinectes paulistanus (Miranda Ribeiro, 1915)	Ca+Br	X[NO]	X	X	X	X	X[NO]	X[NO]	X	UFPB12049; UFRN5803; 5171; 4648; 4735; 4530

Taxon	Distribution	AM	AR	CU	CO	PA	MC	CH	PI	Vouchers
Cynoglossidae										
Symphurus tessellatus (Quoy & Gaimard, 1824)	Ca+SWA	X[NO]		X[L]		X[NO]		X[NO]		UFRN4581; 4690
Carangidae										
Caranx latus Agassiz, 1831 (*)	TA	X	X	X	X	X	X	X	X	UFRN4606; 4812; 4813; 4655; 4683; 4534
Chloroscombrus chrysurus (Linnaeus, 1766) (*)	TA	X[L]	X[L]	X[L]	X	X	X	X[L]	X[L]	UFRN5172
Oligoplites palometa (Cuvier, 1832) (*)	Ca+Br	X	X	X	X[L]	X	X	X	X	UFRN4589; 4674; 4742
Oligoplites saurus (Bloch & Schneider, 1801) (*)	WA	X	X	X	X[L]	X	X	X	X	UFRN4591; 4675; 4771; 4523
Selene vomer (Linnaeus, 1758) (*)	WA			X	X[L]	X	X[NO]	X	X	UFRN4570; 4663; 4773; 4502
Trachinotus carolinus (Linnaeus, 1766) (*)	WA			X[L]			X[NO]			UFPB12067
Trachinotus falcatus (Linnaeus, 1758) (*)	WA	X[L]	X[L]	X	X[L]	X	X	X	X[L]	UFPB12068; UFRN4602; 4629; 4776
CICHLIFORMES										
Cichlidae										
Astronotus ocellatus (Agassiz, 1831) (I)	CF				X[NO]					UFRN5873
Oreochromis niloticus (Linnaeus, 1758) (I)	CF	X[NO]	X[NO]	X[L]	X	X[L]		X[L]	X	UFRN4856; 4492
Pomacentridae										
Abudefduf saxatilis (Linnaeus, 1758) (*)	TA					X	X[NO]			UFPB12059
ATHERINIFORMES										
Atherinopsidae										
Atherinella brasiliensis (Quoy & Gaimard, 1825) (*)	Ca+Br	X	X	X	X	X	X	X	X	UFRN4596; 4820; 4639; 4693; 4519
CYPRINODONTIFORMES										
Poeciliidae										
Poecilia reticulata Peters, 1859 (I)	CF				X[NO]	X[NO]				UFRN4858; 4745
Poecilia sphenops Valenciennes, 1846 (I) (NR)	CF				X[NO]					UFRN5874
Poecilia vivipara Bloch & Schneider, 1801	CF			X[NO]	X[NO]	X[NO]				UFRN4857; 4859; 4880; 5187; 4644; 5185; 5188
Anablepidae										
Anableps anableps (Linnaeus, 1758) (*)	Ca+Br			X[NO]						UFRN4650
BELONIFORMES										
Belonidae										
Strongylura marina (Walbaum, 1792) (*)	WA	X	X	X	X[L]	X	X[NO]	X[NO]	X	UFPB12053; UFRN4556; 4643; 4677; 4680
Strongylura timucu (Walbaum, 1792) (*)	WA	X[NO]	X	X[NO]	X	X	X	X	X[NO]	UFPB12052; UFRN4543; 4876; 4877; 4878; 4615; 4716; 4496; 4497
Hemiramphidae										
Hyporhamphus unifasciatus (Ranzani, 1841) (NT) (*)	WA+EP	X	X[NO]	X	X[NO]	X	X	X	X[NO]	UFRN4577; 4842; 4636; 5176; 4505
MUGILIFORMES										
Mugilidae										
Mugil curema Valenciennes, 1836 (DD) (*)	TA+EP	X	X	X	X	X	X	X	X	UFRN4575; 4852; 4622; 4679; 4738; 4739; 5181
Mugil curvidens Valenciennes, 1836(DD)(*)	Ca+Br	X	X	X	X	X	X	X	X	UFRN4544; 4853; 4638; 5183
Mugil liza Valenciennes, 1836 (NT)	WA	X[L]	X[L]	X[L]	X	X[L]	X	X	X	UFRN4563; 4854; 4667; 4499; 4511; 4513
Mugil rubrioculus Harrison, Nirchio, Oliveira, Ron & Gavíria, 2007 (DD)	Ca+Br		X[NO]	X[NO]	X[NO]	X[NO]	X[NO]	X[NO]	X[NO]	UFRN5192; 5190; 5184; 5186; 4504
PERCIFORMES										
Serranidae										
Mycteroperca bonaci (Poey, 1860) (VU) (*)	WA	X[L]	X[L]	X[L]	X[L]	X	X	X	X[L]	UFRN4607
Scaridae										
Sparisoma radians (Valenciennes, 1840) (*)	Ca+Br		X[NO]	X[NO]		X[NO]	X[NO]	X[NO]		UFRN4579; 4630; 4774
Triglidae										
Prionotus punctatus (Bloch, 1793)	Ca+SWA					X[NO]		X[NO]		UFRN4593; 4715
Scorpaenidae										
Scorpaena cf. *plumieri* Bloch, 1789 (*)	WA				X[L]	X	X[NO]	X[NO]	X[NO]	UFRN4553; 4685; 4500
ACANTHURIFORMES										
Lutjanidae										
Lutjanus alexandrei Moura & Lindeman, 2007 (*)	Br		X[NO]	X	X[NO]		X[NO]	X[NO]	X[NO]	UFRN4612; 4844; 4619; 4769; 4526
Lutjanus analis (Cuvier, 1828) (NT) (*)	WA	X[NO]	X[NO]	X	X	X	X[NO]	X	X	UFRN5801; 4845; 4614; 5177; 5178; 4524
Lutjanus jocu (Bloch & Schneider, 1801) (NT) (*)	TA	X	X[L]	X	X[L]	X[L]	X[L]	X	X[L]	UFRN4546; 4673; 4491
Gerreidae										
Diapterus auratus Ranzani, 1842 (*)	WA	X	X	X	X	X	X	X	X	UFRN4551; 5169; 4661; 4712, 4749; 4508
Diapterus rhombeus (Cuvier, 1829) (*)	Ca+Br	X[NO]		X	X[L]	X	X[NO]	X	X[NO]	UFRN5191; 4660; 5175; 4501
Eucinostomus argenteus Baird & Girard, 1855 (*)	WA+EP	X[NO]	X[NO]	X	X	X	X[NO]	X[NO]	X[NO]	UFRN4557; 4829; 4830; 4624; 5180

Taxon	Distribution	AM	AR	CU	CO	PA	MC	CH	PI	Vouchers
Eucinostomus gula (Quoy & Gaimard, 1824) (*)	WA	X[NO]	X[NO]	X	X[L]	X	X[NO]	X[NO]	X[NO]	UFRN5193; 4626; 4750; 5805; 4518
Eucinostomus havana (Nichols, 1912)	Ca+Br		X[NO]	X[NO]	X[L]	X	X[NO]	X[NO]	X[NO]	UFRN4550; 4662; 4698; 4512
Eucinostomus lefroyi (Goode, 1874) (*)	Ca+Br	X[NO]	X[NO]	X[NO]		X[NO]	X[NO]	X[NO]	X[NO]	UFRN4584; 4668; 4777; 4536
Eucinostomus melanopterus (Bleeker, 1863) (*)	TA	X	X	X	X	X	X	X	X	UFRN4554; 4569; 4831; 4651; 4751; 4489; 4529
Eugerres brasilianus (Cuvier, 1830) (*)	WA	X[NO]		X	X[L]	X	X	X	X	UFPB12048; UFRN4573; 4623; 4688; 4490
Haemulidae										
Genyatremus luteus (Bloch, 1790) (*)	Ca+Br	X	X[L]	X[L]	X[L]	X[L]	X	X	X	UFRN4610; 4488
Haemulon parra (Desmarest, 1823) (*)	Ca+Br			X	X	X[L]	X	X		UFRN4594; 5173; 4620
Haemulopsis corvinaeformis (Steindachner, 1868) (*)	Ca+SWA	X	X	X	X[L]	X	X	X	X	UFRN5802; 4645; 4687; 4520
Orthopristis scapularis Fowler, 1915 (*)	Ca+Br					X[NO]				UFRN4741
Sparidae										
Archosargus probatocephalus (Walbaum, 1792) (DD) (*)	WA			X	X[L]	X[L]		X	X[L]	UFRN4672
Archosargus rhomboidalis (Linnaeus, 1758) (*)	WA		X[NO]	X[NO]		X[NO]		X[NO]		UFRN4599; 4647; 4747
Sciaenidae										
Cynoscion acoupa (Lacepède, 1801) (NT)	Ca+SWA	X[L]	X[L]	X[L]	X[L]	X	X[L]	X[L]	X[L]	UFRN4752
Larimus breviceps Cuvier, 1830	Ca+Br	X[NO]								UFPB12074
Menticirrhus martinicensis (Cuvier, 1830) (DD)	WA	X	X[L]	X[L]	X[L]	X[L]	X	X	X[L]	UFRN4571; 4538
Micropogonias furnieri (Desmarest, 1823)	Ca+SWA	X[L]	X[L]	X	X[L]	X	X[L]	X	X[L]	UFRN4611; 4664; 4743; 4495
Stellifer naso (Jordan, 1889)	Ca+Br	X[NO]			X[L]	X	X[NO]			UFRN4691
Ephippidae										
Chaetodipterus faber (Broussonet, 1782) (*)	WA	X	X[L]	X	X[L]	X	X	X	X	UFRN4583; 4640; 4765; 4494
Acanthuridae										
Acanthurus bahianus Castelnau, 1855 (*)	WA			X[L]	X	X[L]	X[NO]	X[L]	X[L]	UFPB12060; UFRN5168
LOPHIIFORMES										
Ogcocephalidae										
Ogcocephalus vespertilio (Linnaeus, 1758) (*)	Ca+SWA	X[L]	X	X[L]	X[L]	X[L]	X[L]	X	X[L]	UFRN4549
Antennariidae										
Antennarius striatus (Shaw, 1794) (DD) (*)	C		X[NO]	X[L]	X[L]	X[L]		X	X[L]	UFRN4592
TETRAODONTIFORMES										
Diodontidae										
Chilomycterus antennatus (Cuvier, 1816) (*)	TA							X[NO]		UFRN5189
Chilomycterus spinosus (Linnaeus, 1758) (*)	SWA			X[L]	X[L]	X		X[L]		UFRN5182
Tetraodontidae										
Lagocephalus laevigatus (Linnaeus, 1766)	TA			X[L]	X[L]	X[L]	X[NO]	X	X[L]	UFRN4548
Sphoeroides greeleyi Gilbert, 1900 (*)	Ca+Br	X[NO]	X[NO]	X	X[NO]	X[NO]	X[NO]	X[NO]	X[NO]	UFRN4568; 4861; 4631; 4678; 4537
Sphoeroides cf. *spengleri* (Bloch, 1785) (*)	TA							X[NO]	X[NO]	UFRN4555; 4532
Sphoeroides testudineus (Linnaeus, 1758) (DD) (*)	WA	X	X	X	X	X	X	X	X	UFPB12046; UFRN4564; 4862; 4632; 4676; 4493
Monacanthidae										
Aluterus monoceros (Linnaeus, 1758) (NT) (*)	CT							X[NO]		UFPB12070
New occurrences by estuary		31	32	19	19	19	43	35	26	
Total species by estuary		71	72	88	92	95	82	93	76	
Total species reef-associated	73									
Total species	126									

Table 2. Species registered for estuaries in the state of Ceará, Brazil, according to the literature. 1: Menezes and Menezes (1968), 2: Oliveira (1976), 3: Alves and Soares-Filho (1996), 4: Araújo et al. (2000), 5: EEZ (2005), 6: Freitas et al. (2006), 7: Basílio et al. (2009), 8: Soares-Filho et al. (2010), 9: Osório et al. (2011), 10: Costa and Lacerda (2014), 11: Teixeira et al. (2017), 12: Santana et al. (2020), 13: Melo et al. (2021). (I): introduced species. (*): Species associated with reefs (Floeter et al. 2008; Chaves et al. 2013; Freitas and Lotufo 2015; Pinheiro et al. 2018; Freitas et al. 2019; Araújo et al. 2020; Froese and Pauly 2022). Red List (Brasil 2022): CR: Critically Endangered, NT: Near Threatened, VU: Vulnerable, DD: Data Deficient. Geographical distribution: C: cosmopolitan, CT: circumtropical, TA: trans-Atlantic (both sides of the Atlantic), WA: Western Atlantic (both northern and southern hemispheres), SWA: Southwestern Atlantic (northern Brazil to Argentina), SSWA: South-Southwestern Atlantic (southeastern Brazil to Argentina), Ca: Greater Caribbean Province (Florida to Venezuela), Br: Brazilian Province (delta of the Orinoco River, Venezuela to Santa Catarina, Brazil), EP: Eastern Pacific, CF: continental freshwater. The taxonomic order follows Fricke et al. (2022).

Taxon	Distribution	Literature record	speciesLink voucher
CARCHARHINIFORMES			
Carcharhinidae			
Carcharhinus leucas (Müller & Henle, 1839) (NT) (*)	C	5	
Carcharhinus limbatus (Müller & Henle, 1839) (NT) (*)	C	7	
Rhizoprionodon porosus (Poey, 1861) (DD) (*)	Ca+SWA	7	

Taxon	Distribution	Literature record	speciesLink voucher
Sphyrnidae			
Sphyrna tiburo (Linnaeus, 1758) (CR) (*)	WA+EP	3,8	
RHINOPRISTIFORMES			
Rhinobatidae			
Pseudobatos percellens (Walbaum, 1792) (VU)	TA	5	
MYLIOBATIFORMES			
Dasyatidae			
Hypanus marianae (Gomes, Rosa & Gadig, 2000) (VU) (*)	Br	7	
Hypanus say (Lesueur, 1817) (DD)	WA	3,8	
Gymnuridae			
Gymnura micrura (Bloch & Schneider, 1801) (NT)	TA	2,5,7,8	
Aetobatidae			
Aetobatus narinari (Euphrasen, 1790) (DD) (*)	C	5,7,8	
ANGUILLIFORMES			
Ophichthidae			
Myrophis punctatus Lütken, 1852 (*)	WA	2,3,4,5,8	
Ophichthus gomesii (Castelnau, 1855) (*)	WA		OBIS_BR 1937
CLUPEIFORMES			
Engraulidae			
Anchoa spinifer (Valenciennes, 1848)	Ca+Br+EP	5	
Anchoa tricolor (Spix & Agassiz, 1829) (*)	SWA	7	
Lycengraulis batesii (Günther, 1868)	Ca+Br	13	
Clupeidae			
Rhinosardinia bahiensis (Steindachner, 1879)	Br	4,5	
Pristigasteridae			
Chirocentrodon bleekerianus (Poey, 1867)	Ca+Br	5,7	
CHARACIFORMES			
Erythrinidae			
Hoplias malabaricus (Bloch, 1794)	CF	1,2,3,5,7,8	
Serrasalmidae			
Pygocentrus nattereri Kner, 1858	CF	3,8	
Anostomidae			
Leporinus friderici (Bloch, 1794)	CF	3,8	
Schizodon dissimilis (Garman, 1890)	CF	2,3,5,8	
Triportheidae			
Triportheus signatus (Garman, 1890)	CF	2,3,5,8	
Characidae			
Hemigrammus marginatus Ellis, 1911	CF	2	
SILURIFORMES			
Loricariidae			
Hypostomus jaguribensis (Fowler, 1915)	CF	2,3,8	
Loricarichthys derbyi Fowler, 1915	CF	2,3,8	
Auchenipteridae			
Trachelyopterus galeatus (Linnaeus, 1766)	CF	2,3,5,7	
Heptapteridae			
Pimelodella sp. (not identified)	CF	2,3,8	
Ariidae			
Aspistor luniscutis (Valenciennes, 1840)	Br		OBIS_BR 179
Bagre filamentosus (Swainson, 1839)	Ca+Br	3,6,8,12	OBIS_BR 284
AULOPIFORMES			
Synodontidae			
Synodus poeyi Jordan 1887 (*)	Ca+Br		OBIS_BR 2630
HOLOCENTRIFORMES			
Holocentridae			
Holocentrus adscensionis (Osbeck, 1765) (*)	TA	10	
BATRACHOIDIFORMES			
Batrachoididae			
Amphichthys cryptocentrus (Vallenciennes, 1837) (*)	WA	13	
SCOMBRIFORMES			
Stromateidae			
Peprilus paru (Linnaeus, 1758)	WA	5	OBIS_BR 2051
Trichiuridae			
Trichiurus lepturus Linnaeus, 1758	CT	2,4,5,8	OBIS_BR 2696

Taxon	Distribution	Literature record	speciesLink voucher
SYNGNATHIFORMES			
Syngnathidae			
Hippocampus erectus Perry, 1810 (VU) (*)	WA	8	OBIS_BR 1424
Micrognathus crinitus (Jenyns, 1842)	Ca+Br		OBIS_BR 1678
Microphis brachyurus (Bleeker, 1853)	CT	5	
Syngnathus scovelli (Evermann & Kendall, 1896) (*)	Ca+Br		OBIS_BR 2590
GOBIIFORMES			
Eleotridae			
Erotelis smaragdus (Valenciennes, 1837)	Ca+Br		OBIS_BR 972, OBIS_BR 978
Guavina guavina (Valenciennes, 1837)	Ca+Br		OBIS_BR1296
Gobiidae			
Awaous tajasica (Lichtenstein, 1822)	Br		OBIS_BR 266
Ctenogobius shufeldti (Jordan * Eigenmann, 1887)	WA		OBIS_BR 1248
Gobioides broussonnetii (Lacepède, 1800)	WA	1,4,5	OBIS_BR 1205
Microgobius meeki Evermann & Marsh, 1899	Ca+Br		OBIS_BR 1690
CARANGIFORMES			
Centropomidae			
Centropomus ensiferus Poey, 1860	Ca+Br	3,4,5,7,8	OBIS_BR 413
Centropomus pectinatus Poey, 1860	Ca+Br	7	OBIS_BR 441
Paralichthyidae			
Paralichthys sp.	?	13	
Syacium micrurum Ranzani, 1842 (*)	WA	1,4,5,13	UESPIP 658
Achiridae			
Trinectes microphthalmus (Chabanaud, 1928)	Ca+Br		OBIS_BR 2718
Cynoglossidae			
Symphurus plagusia (Bloch & Schneider, 1801)	Ca+Br	2,4,5,8	OBIS_BR 2535
Carangidae			
Caranx crysos (Mitchill, 1815) (*)	TA	5	UESPIP 525
Caranx hippos (Linnaeus, 1766) (*)	TA	2,3,5,7,8	
Hemicaranx sp.	?	11	
Oligoplites saliens (Bloch, 1793) (*)	Ca+SWA	3,5,7,8	
Selene setapinnis (Mitchill, 1815) (*)	WA	5,8	
Trachinotus goodei Jordan & Evermann, 1896 (*)	WA	4,5,7	
Echeneidae			
Echeneis naucrates Linnaeus, 1758 (*)	CT	5,7	UESPIP 555
Remora remora (Linnaeus, 1758) (*)	CT	3,5,8	
CICHLIFORMES			
Cichlidae			
Cichla ocellaris (Bloch & Schneider, 1801) (I)	CF	3,5,8	
Cichlasoma orientale Kullander, 1983	CF	2,3,8	
Pomacentridae			
Stegastes variabilis (Castelnau, 1855) (*)	Br		OBIS_BR 2120
BELONIFORMES			
Belonidae			
Tylosurus crocodilus (Péron & Lesueur, 1821) (*)	CT	8	
Hemiramphidae			
Hemiramphus balao Lesueur, 1821 (DD) (*)	TA	3,5,8	
Hemiramphus brasiliensis (Linnaeus, 1758)(*)	TA		OBIS_BR 1376
Hyporhamphus roberti (Valenciennes, 1847)	Ca+Br		UESPIP 595
MUGILIFORMES			
Mugilidae			
Mugil brevirostris (Ribeiro, 1915) (*)	Br		OBIS_BR 1765
BLENNIIFORMES			
Labrisomidae			
Labrisomus nuchipinnis (Quoy & Gaimard, 1824) (*)	TA	6	OBIS_BR 1473
PERCIFORMES			
Serranidae			
Diplectrum radiale (Quoy & Gaimard, 1824) (*)	WA	2,3,4,5,7,8	OBIS_BR 857
Epinephelus itajara (Lichtenstein, 1822) (CR) (*)	WA	4,5,7,8	OBIS_BR 939
Rypticus randalli Courtenay, 1967	Ca+Br	2,4,5,7	OBIS_BR 2233
Serranus flaviventris (Cuvier, 1829) (*)	WA	8	OBIS_BR 2323
Scaridae			
Sparisoma axillare (Steindachner, 1878) (VU) (*)	Br+EA	6	OBIS_BR 21

Taxon	Distribution	Literature record	speciesLink voucher
Sparisoma rubripinne (Valenciennes, 1840) (*)	Ca+Br	13	
Uranoscopidae			
Astroscopus y-graecum (Cuvier, 1829) (*)	WA	13	
ACANTHURIFORMES			
Lutjanidae			
Lutjanus buccanella (Cuvier, 1828) (*)	Ca+Br	13	UESPIP 645
Lutjanus cyanopterus (Cuvier, 1828) (VU) (*)	Ca+Br	6,9,13	OBIS_BR 12, UESPIP 552
Lutjanus synagris (Linnaeus, 1758) (NT) (*)	WA	3,5,7,8,13	OBIS_BR 1578, UESPIP 662
Lutjanus vivanus (Cuvier, 1828) (NT) (*)	Ca+Br	8	
Ocyurus chrysurus (Bloch, 1791) (NT) (*)	WA		OBIS_BR 1894
Rhomboplites aurorubens (Cuvier, 1829) (NT) (*)	Ca+Br	10	
Gerreidae			
Gerres cinereus (Walbaum, 1792) (*)	Ca+Br	2,4,5,7	
Eugerres sp.	?	13	
Haemulidae			
Anisotremus surinamensis (Bloch, 1791) (DD) (*)	WA	5	
Anisotremus virginicus (Linnaeus, 1758) (*)	WA	5,6,7	OBIS_BR 129
Conodon nobilis (Linnaeus, 1758)	WA	5,8	OBIS_BR 573
Haemulon atlanticus Carvalho, Marceniuk, Oliveira & Wosiacki, 2020 (*)	Ca+Br	3,8	OBIS_BR 1364
Haemulon aurolineatum Cuvier, 1830 (*)	Ca+Br	6	OBIS_BR 1346
Haemulon flavolineatum (Desmarest, 1823) (*)	Ca+Br	5,8	
Haemulon cf. *plumierii* (Lacepède, 1801)(DD) (*)	Ca+Br		UESPIP 550
Paranisotremus moricandi (Ranzani, 1842) (*)	Ca+Br		OBIS_BR 117
Rhonciscus crocro (Cuvier, 1830) (*)	Ca+Br		OBIS_BR 2144
Sciaenidae			
Bairdiella goeldi Marceniuk, Molina, Caires, Rotundo, Wosiacki & Oliveira, 2019	Ca+Br	2,3,4,5,7,8	OBIS_BR 302
Cynoscion leiarchus (Cuvier, 1830)	Ca+Br	2,3,4,5,7,8	OBIS_BR 691
Cynoscion microlepidotus (Cuvier, 1830)	Br	2,4,5,7,8	OBIS_BR 710
Cynoscion virescens (Cuvier, 1830)	Ca+Br	5,8	OBIS_BR 749
Isopisthus parvipinnis (Cuvier, 1830)	Ca+Br	8	OBIS_BR 1461
Macrodon ancylodon (Bloch & Schneider, 1801)	Br+SSWA		OBIS_BR 1597
Menticirrhus cuiaranensis (Marceniuk, Caires, Rotundo, Cerqueira, Siccha-Ramirez, Wosiacki & Oliveira, 2020) (DD) (*)	WA	3,4,5,7,8	OBIS_BR 1651
Nebris microps Cuvier, 1830	Ca+Br		OBIS_BR 1882
Ophioscion punctatissimus Meek & Hildebrand, 1925 (DD)	Ca+Br	5	OBIS_BR 1970
Plagioscion squamosissimus (Heckel, 1840)	CF	2,10	
Paralonchurus brasiliensis (Steindachner, 1875)	WA	8	OBIS_BR 2030, UESPIP 705
Stellifer brasiliensis (Schultz, 1945)	Br		OBIS_BR 2393
Stellifer microps (Steindachner, 1864)	CA+Br		OBIS_BR 1958
Stellifer rastrifer (Jordan, 1889)	Br+SSWA	4,5	OBIS_BR 2432
Stellifer stellifer (Bloch, 1790)	Ca+Br		OBIS_BR 2453
Umbrina coroides Cuvier, 1830	Ca+Br	2,5,8	OBIS_BR 2765
Lobotidae			
Lobotes surinamensis (Bloch, 1790)	CT	2,4,5,7	OBIS_BR 1504
Pomacanthidae			
Pomacanthus arcuatus (Linnaeus, 1758) (DD) (*)	Ca+Br	5,8	OBIS_BR 2114
Acanthuridae			
Acanthurus chirurgus (Bloch, 1787) (*)	WA	6,9	OBIS_BR 24
Acanthurus coeruleus Bloch & Schneider, 1801 (*)	WA	4,5,7	
LOPHIIFORMES			
Ogcocephalidae			
Ogcocephalus nasutus (Cuvier, 1829) (*)	WA	13	
TETRAODONTIFORMES			
Diodontidae			
Chilomycterus antillarum Jordan & Rutter, 1897 (*)	Ca+Br	13	OBIS_BR 510, UESPIP 529
Diodon holocanthus Linnaeus, 1758 (*)	CT		OBIS_BR 833
Diodon hystrix Linnaeus, 1758 (*)	CT		OBIS_BR 839
Tetraodontidae			
Colomesus psittacus (Bloch & Schneider, 1801)	Ca+Br	2,5,7,8	OBIS_BR 558
Ostraciidae			
Lactophrys trigonus (Linnaeus, 1758) (*)	Ca+Br	8	

Taxon	Distribution	Literature record	speciesLink voucher
Monacanthidae			
Cantherhines macrocerus (Hollard, 1853) (*)	WA	13	
Balistidae			
Balistes vetula Linnaeus, 1758 (NT) (*)	TA		OBIS_BR 324
Melichthys niger (Bloch, 1786) (*)	CT	3,8	OBIS_BR 1624
Species reef-associated	62		
Species added from literature		92	
Species added from speciesLink			67
Total species added	119		

Anchoa januaria (Steindachner, 1879)

Figure 2B

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°07′13″S, 038°09′39″W; 27.III.2015; Ronaldo C.G. Lourenço, Lucas Facundo, Wallace A. Sousa leg.; 8 specimens, sex indet., 26.3–57.7 mm SL; UFRN4608 • Paracuru City, Curu estuary; 03°24′27″S, 039°05′02″W; 28.V.2015; Ronaldo C.G. Lourenço, Lucas Facundo, Wallace A. Sousa leg.; 5 specimens, sex indet., 29.9–40.7 mm SL; UFRN4649.

Identification. Pectoral fins short, not reaching posteriorly beyond pelvic-fin base; lower gill rakers on first arch fewer than 45; pseudobranch short, not extending onto inner face of operculum; posterior margin of gill cover without small triangular projection on suboperculum; anus opening nearer to pelvic-fin tips than to anal-fin origin; anal-fin origin more posterior, at or near vertical through midpoint of dorsal fin; anal fin with 25 rays or less; lower gill rakers 23–30; axillary scale of pectoral fin reaching beyond midpoint of fin; maxilla moderate, just reaching posterior margin of preoperculum (Carpenter 2002a).

Anchoviella lepidentostole (Fowler, 1911)

Figure 2C

Material examined. BRAZIL – Ceará • Beberibe City, Pirangi estuary; 04°24′25″S, 037°50′27″W; IV.2015; Wallace A. Sousa leg.; 4 specimens, sex indet., 42.3–48.2 mm SL; UFRN4517.

Identification. Dentition in upper and lower maxilla with reduced conical teeth; number of gill rakers in the lower half of first branchial arch 19–27; anal-fin origin positioned at vertical through dorsal-fin base; upper maxilla long, reaching the anterior margin of preopercle; 12–14 total anal-fin rays; snout pointed (Carpenter 2002a; Vicente et al. 2020).

Family Clupeidae

Harengula clupeola (Cuvier, 1829)

Figure 2D

Material examined. BRAZIL – Ceará • Cascavel City, Malcozinhado estuary; 04°03′25″S, 038°10′51″W; 02.X.2019; Ronaldo C.G. Lourenço, Leonardo M. Pinto leg.; 1 specimen, 78.5 mm SL; UFPB12065.

Identification. W-shaped pelvic scute absent; pelvic scute with lateral arms; series of abdominal scutes present, often keeled; upper jaw without median notch; posterior border of gill opening with 2 fleshy lobes; small, toothed hypomaxilla present between posterior tip of premaxilla and expanded blade of maxilla; no black pigment at tip of dorsal fin; tooth plate on tongue and tooth plate posterior to it broad, width 30% of their combined length; gill rakers 31 on lower limb of first arch; pectoral fin 21% of SL; pelvic fin inserts closer to insertion of pectoral fin than to origin of anal fin (Carpenter 2002a).

Lile piquitinga (Schreiner & Miranda Ribeiro, 1903)

Figure 2E

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′32″S, 038°09′13″W; 21.VIII.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo, Wallace A. Sousa leg.; UFRN4601 • Paracuru City, Curu estuary; 03°24′48″S, 039°03′40″W; 25.VIII.2015; Ronaldo C.G. Lourenço, Paolla M. Braga, Wallace A. Sousa leg.; UFRN4641 • Aquiraz City, Pacoti estuary; 03°50′00″S, 038°25′10″W; 31.XII.2014; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; UFRN4768 • Beberibe City, Pirangi estuary; 04°24′25″S, 037°50′27″W; IV.2015; Wallace A. Sousa leg.; UFRN4531 • Fortaleza City, Cocó estuary; 03°46′23″S, 038°26′12″W; 12.IX.2017; Felipe B. Pereira, Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; UFRN4843.

Identification. W-shaped pelvic scute absent; upper jaw without median notch; posterior border of gill opening evenly rounded; no sharp backward pointing spine on upper part of maxilla; abdomen strongly keeled; bright silver stripe on sides; 7 branched pelvic-fin rays (Carpenter 2002a).

Sardinella aurita Valenciennes, 1847

Figure 2F

Material examined. BRAZIL – Ceará • Beberibe City, Pirangi estuary; 04°24′25″S, 037°50′27″W; IV.2015; Wallace A. Sousa leg.; 3 specimens, sex indet., 27.7–34.5 mm SL; UFRN4527.

Identification. W-shaped pelvic scute absent; pelvic scute with lateral arms; series of abdominal scutes present, often keeled; upper jaw without median notch; posterior border of gill opening with 2 fleshy lobes; no small toothed hypomaxilla between posterior tip of premaxilla and expanded blade of maxilla; last dorsal-fin ray normal; 8 branched pelvic-fin rays; anterior gill

rakers on lower limbs of second and third gill arches lying more or less flat (Carpenter 2002a).

Order Characiformes
Family Erythrinidae

***Hoplerythrinus unitaeniatus* (Spix & Agassiz, 1829)**
Figure 2G

Material examined. BRAZIL – Ceará • Cascavel City, Malcozinhado estuary; 04°05′44″S, 038°12′09″W; 22.V.2019; Ronaldo C.G. Lourenço, Leonardo M. Pinto leg.; 1 specimen, sex indet., 85.2 mm SL; UFPB12058.

Identification. Dorsal rays iii, 9; 35 lateral line scales; maxillary bone without canines; maxillary bone elongate, its tip well beyond posterior margin of the eye; eye small, about 19 times in SL; dorsal fin low; caudal fin plain; dark longitudinal band, caudal spot and opercular ocellus present (Géry 1977).

Family Characidae

***Moenkhausia costae* (Steindachner, 1907)**
Figure 2H

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°08′10″S, 038°09′40″W; 28.III.2015; Ronaldo C.G. Lourenço, Lucas Martínez, Wallace A. Sousa leg.; 1 specimen, sex indet., 41.1 mm SL; UFRN4567 • Eusébio City, Pacoti estuary; 03°50′42″S, 038°25′20″W; 01.V.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 1 specimen, sex indet., 43.2 mm SL; UFRN 4694 • Fortaleza City, Cocó estuary; 03°46′35″S, 038°26′23″W; 02.V.2017; Felipe B. Pereira, Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 5 specimens, 36.7–51.7 mm SL; UFRN4851.

Identification. Premaxillary with 2 rows of teeth; complete lateral line; caudal fin lobes covered with small scales; diagonal black stripe going from the beginning of the anal fin to the tip of the upper lobe of the caudal fin (Britski et al. 1984).

Order Siluriformes
Family Callichthyidae

***Megalechis thoracata* (Valenciennes, 1840)**
Figure 2I

Material examined. BRAZIL – Ceará • Fortaleza City, Cocó estuary; 03°45′43″S, 038°30′15″W; 28.VI.2017; Felipe B. Pereira, Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 1 specimen, 183 mm SL; UFRN4814.

Identification. Infraorbital bones exposed; scapulocoracoid exposed in ventral view; truncated caudal fin; dorsal fin with one spine plus one simple ray, with remaining rays branched; caudal fin with whitish proximal margin, remaining portion dusky or covered by black spots (Tencatt et al. 2017).

Family Auchenipteridae

***Pseudauchenipterus nodosus* (Bloch, 1794)**
Figure 2J

Material examined. BRAZIL – Ceará • Itarema City, Aracatimirim estuary; 02°58′24″S, 039°49′18″W; 08.V. 2019; Leonardo M. Pinto, Ronaldo C.G. Lourenço leg.; 1 specimen, sex indet., 36.1 mm SL; UFPB12075.

Identification. Anal fin long, with more than 15 rays; pelvic fin with 8 rays; forked caudal fin; frontal bone pierced like a honeycomb (Britski et al. 1984).

Family Ariidae

***Sciades parkeri* (Traill, 1832)**
Figure 2K

Material examined. BRAZIL – Ceará • Paracuru City, Curu estuary; 03°24′28″S, 39°05′04″W; 12.I.2015; Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 2 specimens, sex. indet., 58.7–59.7 mm SL; UFRN4669 • Cascavel City, Choró estuary; 04°06′26″S, 038°09′07″W; 10.VI.2015; Ronaldo C.G. Lourenço, Ana Cecília P. Costa, Wallace A. Sousa leg.; 2 specimens, sex. indet., 81.9–89.3 mm SL; UFRN4597.

Identification. Posterior nostrils not connected to each other by a furrow and without a fold of skin; wide nuchal plate, as long or longer than the occipital process; maxillary barbels very long, exceeding the base of the dorsal fin in adults and reaching the base of the pelvic fins in juveniles; anterior margin of convex nuchal plate; posterior portion of the occipital process wide and concave posterior margin (Marceniuk 2005).

Order Aulopiformes
Family Synodontidae

***Synodus bondi* Fowler, 1939**
Figure 2L

Material examined. BRAZIL – Ceará • Itarema City, Aracatimirim estuary; 02°58′03″S, 039°48′17″W; 17.X. 2019; Leonardo M. Pinto, Yasmim Vieira, Ronaldo C.G. Lourenço leg.; 1 specimen, 118.2 mm SL; UFPB12076.

Identification. Scales in lateral line 61; 5 rows of complete scales between lateral line and base of dorsal fin; snout triangular and pointed, its length greater than diameter of eye; tip of pectoral fin falling short of or just reaching pelvic-fin base; no dark spot on tip of upper jaw; predorsal scales 26; anal-fin rays 11; dorsal-fin base as long as or longer than anal-fin base; adipose lids around orbit thick; tip of snout sharply pointed; anterior-nostril flap narrow and tapering to filament distally (Frable et al. 2013).

***Synodus foetens* (Linnaeus, 1766)**
Figure 2M

Material examined. BRAZIL – Ceará • Eusébio City, Pacoti estuary; 03°50′00″S, 038°25′00″W; 03.III.2014; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 1 specimen, 152.0 mm SL; UFRN4775.

Identification. Scales in lateral line 61; 5 rows of complete scales between lateral line and base of dorsal fin; snout triangular and pointed, its length greater than diameter of eye; anal-fin base slightly shorter to longer

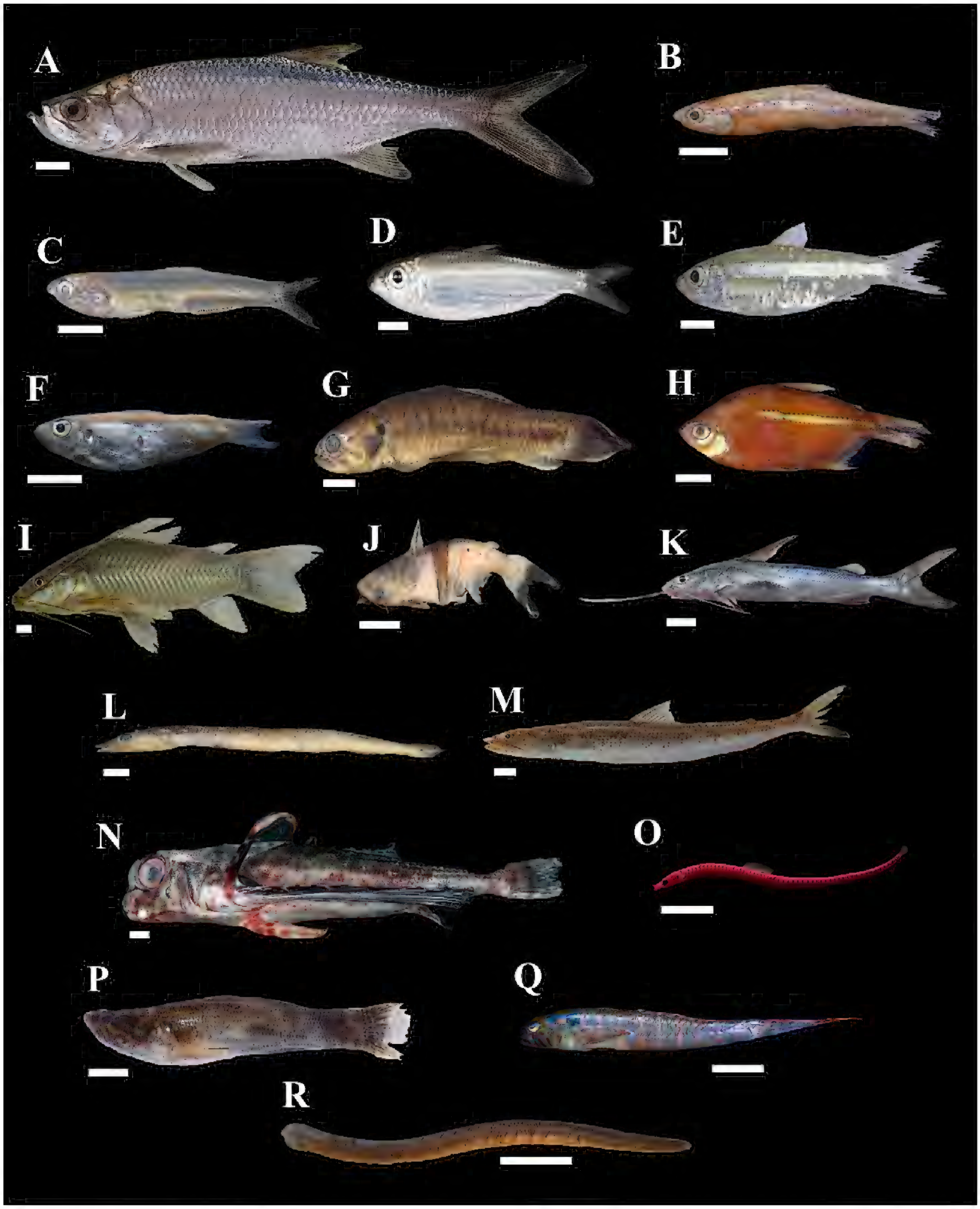

Figure 2. Some fish species recorded in the estuaries of study area. **A.** *Megalops atlanticus*. **B.** *Anchoa januaria*. **C.** *Anchoviella lepidentostole*. **D.** *Harengula clupeola*. **E.** *Lile piquitinga*. **F.** *Sardinella aurita*. **G.** *Hoplerythrinus unitaeniatus*. **H.** *Moenkhausia costae*. **I.** *Megalechis thoracata*. **J.** *Pseudauchenipterus nodosus*. **K.** *Sciades parkeri*. **L.** *Synodus bondi*. **M.** *Synodus foetens*. **N.** *Dactylopterus volitans*. **O.** *Bryx dunckeri*. **P.** *Eleotris pisonis*. **Q.** *Ctenogobius stigmaticus*. **R.** *Synbranchus* cf. *marmoratus*. Scale bars: 10 mm.

than dorsal-fin base; tip of pectoral fin falling short of pelvic-fin base; no dark spot on tip of upper jaw; predorsal scales 24; anal-fin rays 13; dorsal-fin base shorter than anal-fin base; adipose lids around orbit narrow; tip of snout not sharply pointed, slightly rounded; anterior-nostril flap broad and triangular, not tapering to filament (Frable et al. 2013).

***Synodus intermedius* (Spix & Agassiz, 1829)**

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′42″S, 038°09′26″W; 21.VIII.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo, Wallace A. Sousa leg.; 1 specimen, 132.9 mm SL; UFRN4576.

Identification. Dorsal fin with anterior rays not extend-

ing beyond tips of succeeding rays when depressed; lower jaw rounded anteriorly, without fleshy knob; caudal fin with 4 dark bars spanning both lobes; pored scales in lateral line 51; black scapular blotch present on shoulder under gill cover; scapular blotch small and rectangular (length <12% HL); anterior-nostril flap broad and short, not tapering significantly posteriorly and not extending beyond posterior nostril when depressed (Frable et al. 2013).

Order Syngnathiformes
Family Dactylopteridae

***Dactylopterus volitans* (Linnaeus, 1758)**
Figure 2N

Material examined. BRAZIL – Ceará • Aquiraz City, Pacoti estuary; 03°49′07″S, 038°24′36″W; 12.IX.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 1 specimen, 196 mm SL; UFRN4675.

Identification. Head blunt, top and sides encased in a bony fin; angle of preopercle also bearing a long spine, with a serrate keel; jaws with a band of small nodular teeth; spinous and soft dorsal fins separated by a deep notch; anterior 2 dorsal-fin spines adjacent to each other, interconnected by a basal membrane, and not separated from remainder of spinous dorsal fin; anal fin with only 6 soft rays; caudal fin emarginate, with 2 sharp keels on its base; bases of pectoral fins horizontal, the fins divided into 2 sections, an anterior short part of 6 soft rays and a posterior long part of 29 soft rays which reach the caudal-fin base; scales scute-like with sharp keels (Carpenter 2002a).

Family Syngnathidae

***Bryx dunckeri* (Metzelaar, 1919)**
Figure 2O

Material examined. BRAZIL – Ceará • Paracuru City, Curu estuary; 03°24′35″S, 039°04′08″W; 12.I.2015; Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 1 specimen, sex indet., 56.7 mm SL; MNRJ53260.

Identification. Median crest of the trunk interrupted, subcontinuous with the superior caudal crest which, at the height of the anus, originates above the end of the medial lateral crest and rises from there backwards along the upper part of the tail; male brood pouch located on the underside of the tail; anal fin absent (Figueiredo and Menezes 1980).

Order Gobiiformes
Family Eleotridae

***Eleotris pisonis* (Gmelin, 1789)**
Figure 2P

Material examined. BRAZIL – Ceará • Fortaleza City, Cocó estuary; 03°46′14″S, 038°26′55″W; 02.V.2017; Ronaldo C.G. Lourenço, Felipe B. Pereira, Wallace A. Sousa leg.; 1 specimen, sex indet., 64.2 mm SL; UFRN4823 • same locality; 03°45′18″S, 038°29′48″W; 13.XI.2017; Ronaldo C.G. Lourenço, Felipe B. Pereira, Wallace A. Sousa leg.; 3 specimens, sex indet., 28.3–33.0 mm SL; UFRN4824.

Identification. Teeth heteromorphic; no dark spot present on upper pectoral-fin base, or if present not strongly contrasted and not as dark as pigment on nape; second, third, and fourth transverse suborbital neuromast rows on cheek extend below longitudinal row d (2.3.4 pattern) (Pezold and Cage 2001).

Family Gobiidae

***Ctenogobius stigmaticus* (Poey, 1860)**
Figure 2Q

Material examined. BRAZIL – Ceará • Paracuru City, Curu estuary; 03°24′42″S, 039°03′22″W; 04.XI.2014; Ronaldo C.G. Lourenço, Paulo V. Araújo, Wallace A. Sousa leg.; 1 specimen, sex indet., 88.5 mm SL; UFRN4658 • Eusébio City, Pacoti estuary; 03°50′43″S, 038°25′01″W; 22.VI.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 1 specimen, sex indet., 38 mm SL; UFRN4767.

Identification. Two dorsal fins; eyes larger, 15% or more of HL; body robust or elongate; no crest present on nape; body completely scaled; vomer without teeth; shoulder girdle without fleshy lobes; teeth conical, pointed-tipped; sides of head without scales; mouth at end of snout; short lateral cephalic canal with only 2 pores; no gill rakers or lobes on upper arm of first gill arch, 4 or 5 gill rakers on lower arm, gill rakers short and triangulate; total elements in second dorsal fin 12; total elements in anal fin 13; preopercular margin, if pigmented, not more intense than other head pigmentation, and not as distinctly defined; cheek with 3 dark broad vertical bars; laterally projecting, sometimes nearly horizontal, tusk-like canine tooth in middle of lower jaw (Carpenter 2002b).

Order Synbranchiformes
Family Synbranchidae

***Synbranchus* cf. *marmoratus* Bloch, 1795**
Figure 2R

Material examined. BRAZIL – Ceará • Fortaleza City, Cocó estuary; 03°45′17″S, 038°29′47″W; 03.V.2018; Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 1 specimen, sex indet., 55 mm SL; UFRN5170.

Identification. Head moderately bulbous with dorsal profile ascending gradually, straight or with shallow concavity behind eye; maximum body depth at middle of TL 4.2% of TL; caudal length 26.4% of TL (Sabaj et al. 2022).

Remarks. Lima et al. (2017) compiled a list of the Caatinga ichthyofauna, but *S. marmoratus* was replaced by two possible undescribed species; thus, this is the reason for our designation "cf.".

Order Anabantiformes
Family Osphronemidae

***Betta splendens* Regan, 1910**
Figure 3A

Material examined. BRAZIL – Ceará • Fortaleza City, Cocó estuary; 03°45′17″S, 038°29′47″W; 07.III.2018; Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 1♀, 29.9 mm SL; UFRN5166 • same locality; 03°45′17″S, 038°29′47″W; 03.V.2018; Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 1 ♀, 34.2 mm SL; UFRN5167.

Identification. Caudal fin with red distal crescent margin when alive; pelvic fins with all rays elongate; no iridescent scales on opercle, with parallel red vertical bars; head and body stocky, body depth 27.1–32.2% SL (Hui and Ng 2005).

Order Carangiformes
Family Sphyraenidae

***Sphyraena guachancho* Cuvier, 1829**
Figure 3B

Material examined. BRAZIL – Ceará • Fortaleza City, Cocó estuary; 03°46′25″S, 038°26′12″W; 27.VI.2017; Felipe B. Pereira, Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 1 specimen, sex indet., 124.9 mm SL; UFRN4864.

Identification. Pelvic fins inserted in front of origin of first dorsal fin, about midway between anterior tip of lower jaw and base of last anal-fin ray; pectoral fins reaching beyond base of pelvic fins, and to about origin of first dorsal fin; lateral-line scales 112; body greyish or olive brown above, sides silvery with a yellow to golden stripe; broad black bars encircling body (juvenile); edges of pelvic fins, anal fin, and middle rays of caudal fin blackish; no lobes on posterior margin of caudal fin; last rays of soft dorsal and anal fins elongate, 1.8 times longer than penultimate rays (Carpenter 2002b).

Family Bothidae

***Bothus ocellatus* (Agassiz, 1831)**
Figure 3C

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′18″S, 038°09′05″W; 26.I.2015; Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 1 specimen, sex indet., 56.9 mm SL; UFRN4561.

Identification. Ocular-side pelvic-fin base much longer than base of blind-side pelvic fin, with first rays inserted notably anterior to those of blind-side fin; mouth not very large, maxilla not reaching posteriorly to vertical through middle of lower eye; eyes separated by space larger than eye diameter; body depth greater than 60% SL; eye diameter more than 23% HL; eye diameter longer than snout length; 89 dorsal-fin rays; 64 anal-fin rays; caudal fin lacking large spots on distal portion of median fin rays, spots present on caudal fin arranged one above the other (in vertical series); body spotting and mottling pronounced (Carpenter 2002b).

Family Paralichthyidae

***Citharichthys arenaceus* Evermann & Marsh, 1900**
Figure 3D

Material examined. BRAZIL – Ceará • Aquiraz City, Pacoti estuary; 03°49′07″S, 038°24′36″W; 12.IX.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 3 specimens, 50.9-97.9 mm SL; UFRN4714.

Identification. No distinct arch in lateral line above pectoral fin on ocular side and lateral line not prolonged below inferior eye; base of pelvic fin on ocular side on midventral line; urinary papilla on blind side; branched caudal-fin rays 11; mouth large, maxilla less than 3.5 in HL usually reaching posteriorly to vertical through mideye; jaws on blind side not arched; front teeth in jaws enlarged, larger than lateral teeth; both jaws with a single row of fixed (immovable) teeth; scales ctenoid; gill rakers slender and moderately long; no osseous protuberance on snout; upper-jaw length usually greater than 33% of HL; fewer than 18 gill rakers on lower limb of first arch; snout only partially covered with scales or naked; lower jaw not noticeably included in upper jaw when mouth closed; without conspicuous canines overhanging lower jaw; caudal fin without large spots, or with numerous spots; body and median fins not profusely covered with regularly arranged spots and blotches; eye diameter 25% of HL or less; no cephalic spination;dorsal-fin rays 68–84; anal-fin rays 48–63; scales in lateral line 42–50; body depth usually greater than 45% of SL; interorbital space wider, not completely filled by bony ridge; ventral profile of head rounded; body thickness usually greater than 5% of SL; diffuse spot present or absent on caudal peduncle near caudal-fin base; upper first arch gill rakers 3–8; upper-jaw length 39–44% of HL; length of first dorsal-fin ray 22–29% of HL; total gill rakers on first arch 15–21; upper first arch gill rakers 3–7; caudal vertebrae 21–23 (Carpenter 2002b).

***Citharichthys* sp.**
Figure 3E

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′42″S, 038°09′26″W; 21.VIII.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo, Wallace A. Sousa leg.; 1 specimen, sex indet., 93.7 mm SL; UFRN4585 • Beberibe City, Pirangi estuary; 04°24′25″S, 037°50′27″W; II.2015; Wallace A. Sousa leg.; 1 specimen, 79.8 mm SL; UFRN4522.

Identification. Migrating eye on the left side; first dorsal fin ray contiguous to the anterior nostril of the blind side, but always close to it; base of nasal cirrus narrow, filiform aspect, rarely triangular; ventral profile of the head, slightly angled at the level of mandibular articulation; first branchial archs longs and slenders, with 5 + 12 branchial archs; dorsal fins along the blind side, with 79 rays; anal fin, originated at vertical line anteriorly to pectoral fin base in the blind side, with 63 rays;

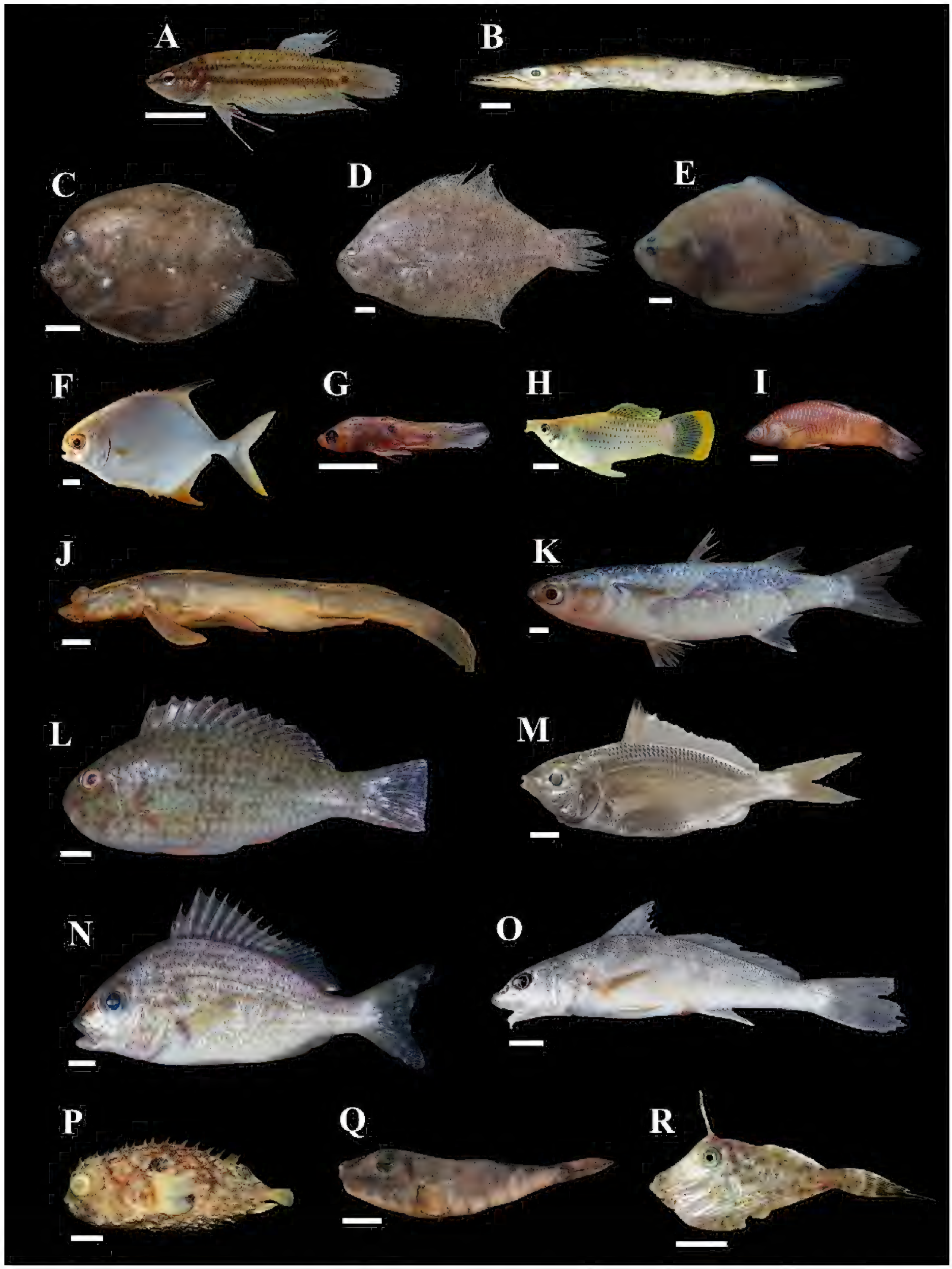

Figure 3. Some fish species recorded in the estuaries of study area. **A.** *Betta splendens*. **B.** *Sphyraena guachancho*. **C.** *Bothus ocellatus*. **D.** *Citharichthys arenaceus*. **E.** *Citharichthys* sp. **F.** *Trachinotus falcatus*. **G.** *Poecilia reticulata*. **H.** *Poecilia sphenops*. **I.** *Poecilia vivipara*. **J.** *Anableps anableps*. **K.** *Mugil rubrioculus*. **L.** *Sparisoma radians*. **M.** *Eucinostomus havana*. **N.** *Orthopristis scapularis*. **O.** *Menticirrhus martinicensis*. **P.** *Chilomycterus spinosus*. **Q.** *Sphoeroides* cf. *spengleri*. **R.** *Aluterus monoceros*. Scale bars: 10 mm.

pectoral fin with 10 in the ocular side and 9 in the blind side; pelvic fins 6 at both sides of the body; caudal fin truncated, with 18 rays; total vertebrae 32, pre-caudal vertebrae 9, and caudal vertebrae 23 (Rocha 2017).

Remarks. We use the designation "sp." for what is possibly a new species of *Citharichthys*.

Family Carangidae

***Trachinotus falcatus* (Linnaeus, 1758)**
Figure 3F

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′43″S, 038°09′26″W; 21.VIII.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo, Wallace A. Sousa leg.; 1 specimen, sex indet., 74.2 mm SL; UFRN4602 • Paracuru City, Curu estuary; 03°24′32″S, 039°03′48″W; 05.XI.2014; Ronaldo C.G. Lourenço, Paulo V. Araújo, Wallace A. Sousa leg.; 1 specimen, sex indet., 98.5 mm SL; UFRN4629 • Eusébio City, Pacoti estuary; 03°49′11″S, 038°24′34″W; 21.VI.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 1 specimen, sex indet., 76.2 mm SL; UFRN4776 • Cascavel City, Malcozinhado estuary; 04°05′44″S, 038°12′09″W; 13.II.2020; Ronaldo C.G. Lourenço, Leonardo M. Pinto, Jorge I.S. Botero leg.; 1 specimen, sex indet., 38.7 mm SL; UFPB12068.

Identification. Bases of soft dorsal and anal fins about equal in length; no caudal peduncle grooves; dorsal-fin rays 17–21; anal-fin rays 16–19 (Carpenter 2002b).

Order Cyprinodontiformes
Family Poeciliidae

***Poecilia reticulata* Peters, 1859**
Figure 3G

Material examined. BRAZIL – Ceará • Eusébio City, Pacoti estuary; 03°50′43″S, 038°25′01″W; 07.IX.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 1 ♀, 30.2 mm SL; UFRN4745 • Fortaleza City, Cocó estuary; 03°45′12″S, 038°28′58″W; 03.V.2017; Felipe B. Pereira, Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 10 specimens, 5♂, 12.2–13.9 mm SL, 5 ♀, 13.1–20.9 mm SL; UFRN4858.

Identification. Mouth superior; dorsal-fin rays 6 or 7; longitudinal series with 26–30 scales; pectoral fins with 12 or more rays; gonopodium with a retrorse hook on ray 5; the fleshy palp elongated, extending well beyond the tip; ventral spines on the third gonopodial ray large, giving the gonopodium a bulb-like appearance; body silvery, with dots, stripes and blotches in males (McDowall 1999; Poeser 2003).

***Poecilia sphenops* Valenciennes, 1846**
Figure 3H

New record. BRAZIL – Ceará • Fortaleza City, Cocó estuary; 03°46′12″S, 038°26′14″W; 22.VI.2021; Ronaldo C.G. Lourenço, Leonardo M. Pinto, Jorge I.S. Botero leg.;1 ♂, 42.5 mm SL; UFRN5874.

Identification. Dorsal-fin rays 9; blueish and reddish spots in males, extending from humeral region to caudal peduncle in the body sides; caudal fin with yellow band (Poeser 2003).

Remarks. In addition to being the first record from the estuaries of study region, this is the first record of this introduced species in the Mid-Northeastern Caatinga ecoregion.

***Poecilia vivipara* Bloch & Schneider, 1801**
Figure 3I

Material examined. BRAZIL – Ceará • Paracuru City, Curu estuary; 03°24′47″S, 039°03′27″W; 27.V.2015; Ronaldo C.G. Lourenço, Lucas Facundo, Wallace A. Sousa leg.; 1 ♀, 25.2 mm SL; UFRN4644 • Eusébio City, Pacoti estuary; 03°49′24″S, 038°25′00″W; 23.VIII.2018; Ronaldo C.G. Lourenço, Leonardo M. Pinto, Gabriela A. Valentim leg.; 10 specimens; UFRN5185 • same locality; 03°49′58″S, 038°25′13″W; 25.IX.2018; Jorge I.S. Botero, Ronaldo C.G. Lourenço, Leonardo M. Pinto; Gabriela A. Valentim leg.; 4 specimens; UFRN5188 • Fortaleza City, Cocó estuary; 03°45′41″S, 038°28′21″W; 27.VI.2017; Felipe B. Pereira, Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 6 specimens, 3 ♂, 33.2–37.7 mm SL, 3 ♀, 33.3–35.8 mm SL; UFRN4859 • same locality; 03°46′14″S, 038°26′55″W; 12.IX.2017; Felipe B. Pereira, Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 8 specimens, 4 ♂, 23–35.2 mm SL, 4 ♀, 37.4–43.5 mm SL; UFRN4857 • same locality; 03°45′17″S, 038°29′47″W; 13.IX.2017; Felipe B. Pereira, Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 3 ♂, 14.9–18.5 mm SL; UFRN4880 • same locality; 03°46′14″S, 038°26′55″W; 02.V.2018; Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 10 specimens, 5 ♂, 24.8-33.2 mm SL, 5 ♀, 30.3–38.2 mm SL; UFRN5187.

Identification. Conspicuous sexual color dimorphism, males more colorful than females; pelvic fin of the mature males posteriorly displaced, its origin near the anal fin origin; females without developed urogenital papilla, and normally without spot in flank; first ray of gonopodium serrated (Britski et al. 1984; Gonçalves et al. 2017).

Family Anablepidae

***Anableps anableps* (Linnaeus, 1758)**
Figure 3J

Material examined. BRAZIL – Ceará • Paracuru City, Curu estuary; 03°24′32″S, 039°03′48″W; 12.I.2015; Ronaldo C.G. Lourenço, Wallace A. Sousa leg.; 1 specimen, 129 mm SL; UFRN4650.

Identification. Body elongate, depressed anteriorly, laterally compressed posteriorly; head flattened; mouth upturned and terminal; teeth unicuspid; eyes large, protruding above skull and divided horizontally by band of opaque tissue into upper and lower halves, retina similarly divided, this arrangement allowing for simultaneous aerial and aquatic vision. No spines in fins; dorsal fin set far posteriorly on body with 9 soft rays; anal fin anterior to dorsal fin with 11 soft rays, anal fin in adult males forms a scaled tubular intromittent organ (gonopodium); caudal fin rounded, often with an indistinct lower lobe; pectoral fins rounded and inserted at or slightly below midbody, with 25 soft rays; pelvic

fins abdominal in position, with 6 soft rays; scales large, fewer than 64 scales in midlateral scale row (Carpenter 2002a).

Order Mugiliformes
Family Mugilidae

***Mugil rubrioculus* Harrison, Nirchio, Oliveira, Ron & Gavíria, 2007**
Figure 3K

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′36″S, 038°09′18″W; 10.VI.2015; Ronaldo C.G. Lourenço, Ana Cecília P. Costa, Wallace A. Sousa leg.; 1 specimen, sex indet., 132.6 mm SL; UFRN5192 • Paracuru City, Curu estuary; 03°24′42″S, 039°03′24″W; 25.VIII.2015; Ronaldo C.G. Lourenço, Paolla M. Braga, Wallace A. Sousa leg.; 3 specimens, sex indet., 108.0–147.7 mm SL; UFRN5190 • Eusébio City, Pacoti estuary; 03°49′41″S, 038°25′02″W; 26.XII.2014; Ronaldo C.G. Lourenço, Elieta A. Ramos leg.; 1 specimen, 174 mm SL; UFRN5184 • same locality; 03°49′22″S, 038°24′47″W; 19.III.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 1 specimen, sex indet., 128.6 mm SL; UFRN5186.

Identification. Anal fin III, 9; origin of first (spinous) dorsal fin on middle of distance between snout tip and caudal-fin base; tip of pectoral fin falling short of vertical through first (spinous) dorsal-fin origin; pectoral fin with ii+14–16 rays; 35–39 oblique scale rows from dorsal limit of pectoral-fin base to caudal-fin base; 12 or 13 longitudinal scale rows from dorsal-fin origin to pelvic-fin origin; conspicuous black spot present on anterodorsal portion of second dorsal fin contrasting with lighter color of remainder of fin; basal portion of pectoral fin dusky or with small usually inconspicuous dark spot covering bases of two unbranched rays and of dorsalmost six or seven branched rays; iris orange-reddish in live or recently preserved specimens (Menezes et al. 2015).

Order Perciformes
Family Scaridae

***Sparisoma radians* (Valenciennes, 1840)**
Figure 3L

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary;04°06′59″S, 038°09′38″W; 21.VIII.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo, Wallace A. Sousa leg.; 2 specimens, sex indet., 68.6–87.9 mm SL; UFRN4579 • Paracuru City, Curu estuary; 03°24′37″S, 039°04′24″W; 25.VIII.2015; Ronaldo C.G. Lourenço, Paolla M. Braga, Wallace A. Sousa leg.; 4 specimens, sex indet., 40.6–57.8 mm SL; UFRN4630 • Aquiraz City, Pacoti estuary; 03°49′06″S, 038°24′36″W; 02.V.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 2 specimens, sex indet., 42–42.3 mm SL; UFRN4774.

Identification. Teeth fused to form beak-like plates, either with teeth visible on the margin or without individual teeth visible; body depth contained 2.5–3.0 times in SL; jaws with underbite (front edge of lower jaw outside upper jaw when mouth is closed); median predorsal scales 4; no black spot at upper base of pectoral fin; gill rakers 10–16; 2 midventral scales between pelvic fins on ventral surface near pelvic-fin base; initial phase either striped with narrow dark lines on a lighter background, or mottled and non-descript (Carpenter 2002b).

Order Acanthuriformes
Family Gerreidae

***Eucinostomus havana* (Nichols, 1912)**
Figure 3M

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′43″S, 038°09′27″W; 27.III.2015; Ronaldo C.G. Lourenço, Lucas Martínez, Wallace A. Sousa leg.; 2 specimens, sex indet., 75–81.6 mm SL; UFRN4550 • Paracuru City, Curu estuary; 03°24′42″S, 039°03′23″W; 28.V.2015; Ronaldo C.G. Lourenço, Lucas Facundo, Wallace A. Sousa leg.; 1 specimen, sex indet., 75.1 mm SL; UFRN4662 • Aquiraz City, Pacoti estuary; 03°49′22″S, 038°24′47″W; 21.VI.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 2 specimens, sex indet., 84.1–86.7 mm SL; UFRN4698 • Beberibe City, Pirangi estuary; 04°23′50″S, 037°49′07″W; VI.2015; Wallace A. Sousa leg.; 1 specimen, sex indet., 85 mm SL; UFRN4512.

Identification. Margin of preopercle smooth; body oblong to moderately deep, the depth 2.4–3.3 times in SL; scales on each side of depressed, naked area over premaxillary process extend forward of vertical line from anterior margin of orbit; pelvic fins colourless; pectoral fins scaled only basal portions scaled in young (Carpenter 2002b).

Family Haemulidae

***Orthopristis scapularis* Fowler, 1915**
Figure 3N

Material examined. BRAZIL – Ceará • Aquiraz City, Pacoti estuary; 03°49′06″S, 038°24′36″W; 02.V.2015; Ronaldo C.G. Lourenço, Paulo V. Araújo leg.; 1 specimen, sex indet., 98.8 mm SL; UFRN4741.

Identification. 58 scales with pores in lateral line to caudal fin base; 10 rays in dorsal fin; body without very conspicuous vertical bars; large and conspicuous black humeral spot above pectoral fin base inconspicuous; small black spot on rear border of operculum absent; second ray of anal fin longer than third ray; second ray of anal fin thicker than third ray; 12 scales above lateral line (Marceniuk et al. 2019a).

Family Sciaenidae

***Menticirrhus martinicensis* (Cuvier, 1830)**
Figure 3O

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′27″S, 038°09′12″W; 27.V.2015;

Ronaldo C.G. Lourenço, Lucas Martínez, Wallace A. Sousa leg.; 1 specimen, sex indet., 104.7 mm SL; UFRN 4571.

Identification. Soft dorsal fin with scales along its base; dorsal-fin rays 23; pectoral-fin tip surpassing tip of depressed pelvic fin; body with irregular dark bars; body with 8 or 9 diffused bars, second and third bars forming a faint V below nape and spinous dorsal fin; spinous dorsal fin lower, not reaching base of second soft ray; dorsal profile slightly convex, without evident hump (Marceniuk et al. 2020).

Order Tetraodontiformes
Family Diodontidae

***Chilomycterus antennatus* (Cuvier, 1816)**

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′23″S, 038°09′13″W; 24.VIII.2014; Ronaldo C.G. Lourenço, Paulo V. Araújo; Wallace A. Sousa leg.; 1 specimen, 71.5 mm SL; UFRN5189.

Identification. Body spines fixed in an erect position and with 3 roots; no spines wholly on caudal peduncle; 9 caudal-fin rays; nasal organ of adults a short, hollow tentacle with 2 openings; fins without spots; a large (about equal to 1 eye diameter) tentacle above eye; colour pattern dominated by large blotches with small spots scattered on back and sides, spots on fins only basally (Carpenter 2002b).

***Chilomycterus spinosus* (Linnaeus, 1758)**
Figure 3P

Material examined. BRAZIL – Ceará • Aquiráz City, Pacoti estuary; 03°49′11″S, 038°24′42″W; 23.VIII.2018; Ronaldo C.G. Lourenço, Leonardo M. Pinto; Gabriela A. Valentim leg.; 1 specimen, 70.2 mm SL; UFRN5182.

Identification. Body spines fixed in an erect position and with 3 roots; no spines wholly on caudal peduncle; 9 caudal-fin rays; nasal organ of adults a short, hollow tentacle with 2 openings; fins without spots; tentacles above eyes absent; no black lines on back and sides; background dark with diffuse lighter spots (Carpenter 2002b).

Family Tetraodontidae

***Sphoeroides* cf. *spengleri* (Bloch, 1785)**
Figure 3Q

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′27″S, 038°09′11″W; 27.V.2015; Ronaldo C.G. Lourenço, Lucas Martínez, Wallace A. Sousa leg.; 1 specimen, sex indet., 75.7 mm SL; UFRN 4555 • Beberibe City, Pirangi estuary; 04°23′59″S, 37°49′18″W; XI.2015; Felipe B. Pereira leg.; 1 specimen, sex indet., 59.5 mm; UFRN4532.

Identification. Nostrils easily visible with the naked eye; dorsal surface posterior to eyes smooth, without a distinct keel; eyes not accentuated by dark blue or green radiating lines; anal-fin rays 9; caudal fin truncate; dorsal fin rays 9; dorsum variously marked, but not with 5 or 6 distinct dark bars; body with prickles (prickles not exposed, but present beneath tiny pores in the integument); interorbit of moderate to narrow width, 8% of SL; lappets present on dorsal and/or lateral surfaces; cheeks variously pigmented; lower lateral surfaces marked with spots, not with tiny black flecks or speckles; pectoral-fin rays 13; lower cheek with a row of 4–6 very distinct round spots, or with many discrete spots of various shapes, but not with 3 or 4 vague diagonal blotches; no beard-like chin markings; lower margin of lateral surface bounded by a regular series of distinct, uniform, rounded spots, 6 anterior and 7 posterior to the pectoral fin; caudal fin with dark, sharply defined proximal and distal bars (Carpenter 2002b).

Remarks. We use the designation "cf." because Araujo et al. (2022) found Caribbean and Brazilian populations of *S. spengleri* to be disjunct.

Family Monacanthidae

***Aluterus monoceros* (Linnaeus, 1758)**
Figure 3R

Material examined. BRAZIL – Ceará • Cascavel City, Choró estuary; 04°06′31″S, 038°09′13″W; 29.I.2021; Leonardo M. Pinto, Ronaldo C.G. Lourenço, Jorge I.S. Botero leg.; 2 specimens, sex indet., 41.5-43.6 mm SL; UFPB12070.

Identification. Pelvic fin absent and without any obvious enlarged encasing scales (a rudimentary encasing scale sometimes present, but difficult to see with the unaided eye and not at end of pelvis); dorsal-fin rays 43–50; anal-fin rays 46–52; pectoral-fin rays modally 14;caudal peduncle longer than deep; caudal fin relatively short, 18–26% of SL (Carpenter 2002b).

Discussion

The observed pattern of family diversity is compatible with the results of Andrade-Tubino et al. (2008), who found the families Sciaenidae, Gerreidae, Gobiidae, and Haemulidae with the greatest number of species in northeastern Brazilian estuaries. Other surveys of the estuarine fish fauna from other regions of northeastern Brazil (between Rio Grande do Norte and Bahia) found from 71 to 145 species (Lopes et al. 1998; Vasconcelos-Filho and Oliveira 1999; Paiva et al. 2008; Reis-Filho et al. 2010; Xavier et al. 2012; Oliveira and Pessanha 2014; Paiva et al. 2014; Reis-Filho and Santos 2014; Sales et al. 2016; Costa et al. 2017; Medeiros et al. 2019). Other compilations on fish diversity in northeastern Brazilian estuaries have included up to 190 species (Andrade-Tubino et al. 2008; Paiva and Araújo 2010), excluding synonyms and misidentifications.

It is possible that all the recorded species, especially the marine and estuarine ones, occur in each of the surveyed estuaries, with differences in abundance resulting from hydrological and geomorphological parameters, habitat and resource availability, and the amount of

environmental impacts (Baker et al. 2015; Pasquaud et al. 2015; Santana et al. 2015; Sheaves 2016). For example, *Chloroscombrus chrysurus* was only captured in Cocó estuary, but during the study period specimens were seen in the catches of fishermen exploiting other estuaries. Likewise, *Batrachoides surinamensis* was not captured in Pacoti estuary, but local fishermen reported this species there during the rainy season. According to Potter et al. (2015), some fishes only enter estuaries sporadically or do not venture far beyond the lower or upper zone, leading to gaps in estuarine fish inventories.

Our survey revealed a predominance of marine fishes (111 species; 88%). A similar predominance of marine fishes may be observed in other estuaries from Northeastern to Southern Brazil (Vasconcelos-Filho and Oliveira 1999; Paiva et al. 2009; Reis-Filho et al. 2010; Vilar et al. 2011; Passos et al. 2013), indicating the importance of estuary environments for the maintenance of marine species that use estuaries for reproduction, feeding, growth, and shelter (Elliott et al. 2007). In our survey only 16 species (~13%) could be considered estuarine residents capable of completing their life cycle within this ecosystem (Paiva et al. 2009; Reis-Filho et al. 2010; Mai and Vieira 2013; Marceniuk et al. 2017b; Favero et al. 2019). Northern and northeastern Brazil have similar percentages of resident estuarine species, as demonstrated by Vasconcelos-Filho and Oliveira (1999) (16.6%), Paiva et al. (2009) (14%), Carvalho-Neta et al. (2011) (10.5%), and Mourão et al. (2014), (16.4%), but in southern regions of the country the percentage of resident species is higher (23–35%) (Reis-Filho et al. 2010; Hoeinghaus et al. 2011; Vilar et al. 2011; Passos et al. 2013; Pichler et al. 2015; Solari et al. 2015). Future studies are needed to prove this possible pattern; however, this pattern may be the result of different sampling methodologies or species guild classifications.

Seventy-five species recorded by us are associated with reefs, reflecting the importance of estuaries as a stage in the life cycle of many fishes or as recruitment grounds (Xavier et al. 2012; Sales et al. 2016; Litvin et al. 2018). The large proportion of resident estuarine species associated with reefs (seven; 43%) suggests that part of their life cycle is extra-estuarine. More ecological research is necessary to understand the relative importance of different aquatic environments for these species at different stages of their development (Bradley et al. 2019).

The small number of freshwater fishes recorded may be explained by the high salinity of the sampled estuaries or factors identified by Whitfield (2015), including strong competition and predation with marine species, the abundance of avian predators, the unavailability of upstream freshwater food sources, and habitat disconnectivity due to damming. Moreover, the observed continental freshwater fishes are physiologically secondary or peripheral and are known to tolerate moderate levels of salinity (Myers 1949). The freshwater families recorded by Oliveira (1976) and Alves and Soares-Filho (1996) in the estuary of the Jaguaribe river (Ceará) point to a richer freshwater ichthyofauna in the recent past. At many sampling sites, the assemblage may have changed as a result of local extinctions or rarity of sensitive species. Furthermore, all the introduced species recorded in the literature or sampled in this study are of continental origin.

Five non-native species were recorded in the sampled estuaries. At least four of these are exploited by the aquarium trade (*A. ocellatus*, *B. splendens*, *P. reticulata*, and *P. sphenops*) and one is farmed (*O. niloticus*) (Leão et al. 2011; Brito et al. 2013). All five are found in several river basins in the Mid-Northeastern Caatinga, as shown by Rodrigues-Filho et al. (2016), Lima et al. (2017), Berbel-Filho et al. (2018), and Medeiros et al. (2019). *Poecilia sphenops* is reported from the Northeastern Atlantic Forest ecoregion in Sergipe state (Brito et al. 2013; Lima et al. 2017), and our data on this species represents the first record of this non-native species in the Mid-Northeastern Caatinga ecoregion. Lima et al. (2017) listed 12 non-native species in the Mid-Northeastern Caatinga; our new record of *P. sphenops* from Cocó river raises the number of non-native species in the Mid-Northeastern Caatinga ecoregion to 13 non-native species.

A greater and more consistent sampling effort, with voucher specimens, is required to effectively confirm some literature records. Nevertheless, it should be kept in mind that biological communities are subject overtime to substantial fluctuations due to both natural and anthropic factors. We discuss here selected species reported in the literature. In a large taxonomic study using molecular, cytogenetic, and morphological methods, Menezes et al. (2015) reviewed the mullet species occurring in the Western Atlantic. They updated the distribution of mullets along the Brazilian coast and concluded that *Mugil trichodon* Poey, 1875 is limited to the southern Caribbean, while the similar species occuring at the mouth of the Amazon river is *M. curvidens*, making it necessary to update earlier Brazilian reports of the former species. Menezes et al. (2015) also observed that *M. incilis* Hancock, 1830 occurs from Venezuela to Maranhão and is closely associated with freshwater. This species was recorded by the EEZ program (2005) and by Basílio et al. (2009), but these cases may be misidentifications. Basílio et al. (2009) also reported *M. platanus* Günther, 1880 (a synonym for *M. liza*) in the estuary of the Curu river. Accordingly, the mullet species sampled in the present study were identified as *M. curema*, *M. curvidens*, *M. liza*, *M. rubrioculus*, and *M. brevirostris*.

Lycengraulis batesii (Günther, 1868) was recorded by the EEZ program (2005), but its natural distribution is the coastal and interior waters of the Amazon and the Orinoco rivers (Fricke et al. 2022). The species was recorded only from interviews, which can lead to spurious reports due to the great morphological similarity of *L. batesii* to *L. grossidens*. Thus, this may be another case of a misidentification, as suggested by Basílio et al. (2009). *Genidens barbus* (Lacepède, 1803)

was also reported by the EEZ program (2005), but as the distribution of this catfish is thought to be limited to southern and southeastern Brazil and Argentina, the interviewed fishermen may have mistaken it for another catfish species (e.g., *Sciades* spp.). Finally, Soares-Filho et al. (2010) reported *Notarius grandicassis* (Valenciennes, 1840), a species recently redescribed as *Notarius parmocassis* (Valenciennes, 1840). However, the latter has never been observed in estuaries (Marcenuik et al. 2017a).

Recent taxonomic reviews have caused the names applied to a number of local records to change. Marceniuk et al. (2019a) redescribed two species of the genus *Orthopristis* Girard, 1858, showing that *O. scapularis* occurs from Colombia to northeastern Brazil, while *O. ruber* (Cuvier, 1830) is distributed along the shores of southern and southeastern Brazil. Marceniuk et al. (2019b) also demonstrated that the local taxon previously given as *Bairdiella rhonchus* (Cuvier, 1830) is a another species recently described as *B. goeldi* Marceniuk, Molina, Caires, Rotundo, Wosiacki & Oliveira, 2019, which is distributed along the Brazilian coast, from northern Pará to Santa Catarina, while *B. rhonchus* is a Caribbean species. Furthermore, Marceniuk et al. (2020) found *Menticirrhus americanus* (Linnaeus, 1758) to be limited to the northwestern Atlantic and revalidated a previously believed junior synonym, *M. martinicensis*, as the species in the southwestern Atlantic. Likewise, *M. littoralis* (Holbrook, 1847) is now believed to be *M. cuiaranensis* (Marceniuk et al. 2020). Carvalho et al. (2020) redescribed *Haemulon steindachneri* (Jordan & Gilbert, 1882) as native to the eastern Pacific, while the species known from Costa Rica to southern Brazil is *H. atlanticus*, a recently described species. Finally, Araujo et al. (2022) found disjunct populations of *Scorpaena plumieri* and *Sphoeroides spengleri* between the Caribbean and Brazil, but lineages in the Brazilian Province likely represent a species not yet formally recognized. Therefore, we designate the two species as *S.* cf. *plumieri* e *S.* cf. *spengleri*. According to Fricke et al. (2022), records of *Albula vulpes* from northern Brazil need verification; *A. vulpes* was previously thought to be a circum-global species in warm seas, but apparently it is a species complex. Thus, we use *Albula* cf. *vulpes*.

Loricaria parnahybae Steindachner, 1907 was reported by Alves and Soares-Filho (1996) in the estuary of the Jaguaribe river, but this species is naturally distributed in the Maranhão–Piauí ecoregion (Lima et al. 2017) and may have been confounded with *Loricarichthys* Bleeker, 1862—probably *L. derbyi*, which occurs in the Mid-Northeastern Caatinga (Lima et al. 2017). Similarly, *Hypostomus plecostomus* (Linnaeus, 1758) and *Pimelodella cristata* (Müller & Troschel, 1849) do not occur in this region: the former is probably *Hypostomus jaguribensis* while the latter appears to be *Pimelodella dorseyi* Fowler, 1941, which is native to the basin or ecoregion (Lima et al. 2017). These species were reported in a recent study on the fauna of the Jaguaribe river basin (Rodrigues-Filho et al. 2020).

In some cases, a species may be morphologically similar to another, far more abundant species, raising doubts about whether it has been correctly reported. For example, *Chirocentrodon bleekerianus* (Poey, 1867) was recorded by the EEZ program (2005) in all local estuaries, but we did not find it in our study, and *C. bleekerianus* can be difficult to distinguish from locally occurring engraulids. *Anchoa tricolor*, which was reported by Basílio et al. (2009) in the Curu estuary, was maintained on our list of regional fishes despite a lack of voucher specimens to confirm its occurrence in estuaries. The occurrence of *Lutjanus cyanopterus* in the estuaries of Pacoti and Jaguaribe was based on underwater observations by Osório et al. (2011) and Freitas et al. (2006), respectively. This form of surveying can lead to misidentification, as in the case of *L. alexandrei*, which was also reported by Osório et al. (2011) and collected in more recent studies. However, considering the natural distribution of *L. cyanopterus*, in the Western Atlantic from Bermuda to Santa Catarina, Brazil (Sanches et al. 2012), its occurrence in our region cannot be dismissed. The same is true for *Colomesus psittacus*, *Gerres cinereus*, and a number of carangids and sciaenids. As for seahorses, little is known about their distribution in Brazilian waters, and the taxonomy is disputed. The only species recorded in the present study was *Hippocampus reidi*, but there is evidence that *H. erectus* also occurs along the Brazilian coast, and it is exploited by the aquarium trade (Gurjão and Lotufo 2018).

Due to the long duration and large area covered by our study, the inventory of fishes from seasonally hypersaline estuaries in northeastern Brazil has increased considerably from what was previously known. In our study, we provide an updated list of the fish species occurring in estuaries along the coast of Ceará, with identifications confirmed by experts. This is the most comprehensive survey of estuarine fish species from the semiarid coastal regions of Brazil, partly because it was done at various times of the year and in different estuarine zones. Many species were added to the previous lists of this region. Overall, the many species found highlight the importance of these ecosystems as shelter, as well as feeding grounds and nurseries for marine- and estuarine-dependent fishes. Many of these species are commercially exploited, either consumed, marketed by subsistence fishermen, or sold in the aquarium trade (Barletta and Costa 2009; Basílio and Garcez 2014; Gurjão and Lotufo 2018). This illustrates the role of estuaries as a source of income and animal protein for local populations. Our results expand the current knowledge of the fish fauna and helps support the management of three conservation units: EPA of the Pacoti estuary, EPA of the Curu estuary, and Cocó State Park.

In conclusion, 245 species were recorded (126 species in our samples and 119 species from the literature). The majority was marine species and widely distributed in the Atlantic, with the orders Acanthuriformes, Carangiformes, and Clupeiformes most represented. Our study is highly important, as it explores a region vulnerable

to the effects of climate change, which include declining rainfall, rising sea levels, decreased land-to-ocean matter flux, acidification, intensification of extreme weather events, eutrophication and hypoxia, and detrimental changes in biogeochemical processes (Ward et al. 2016; Lauchlan and Nagelkerken 2020; Soares et al. 2021). The current inventory fills important gaps in our knowledge of biodiversity in seasonally hypersaline estuaries in the semiarid coastal regions of Brazil and is intended as a point of departure for more comprehensive research into the fish fauna of the region.

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Conceptualization: RCGL. Data curation: SMQL, LSM, RCGL, TPAR, LMP. Formal analysis: RCGL. Funding acquisition: JISB. Investigation: WAS, FBP, LMP, RCGL. Methodology: RCGL. Project administration: JISB. Supervision: JISB. Writing – original draft: RCGL. Writing – review and editing: LMP, SMQL, WAS, TPAR, JISB, FBP, LSM.

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